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POWER

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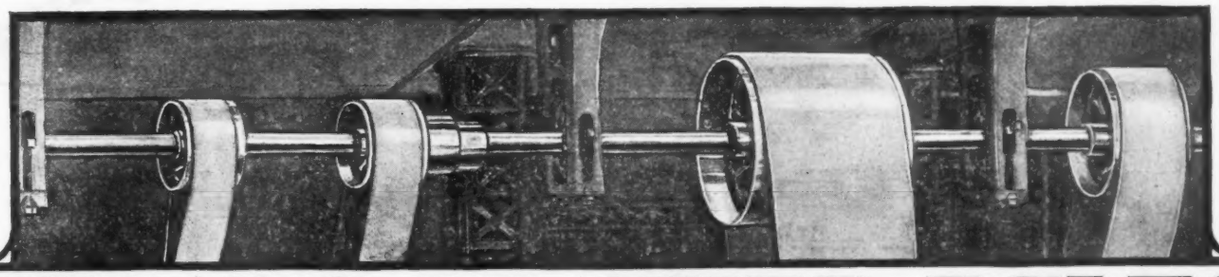

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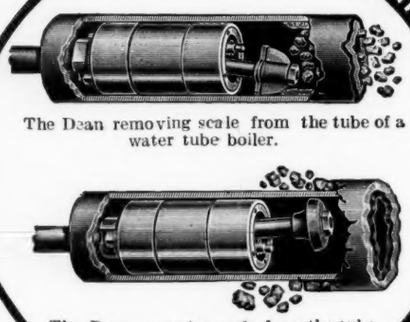

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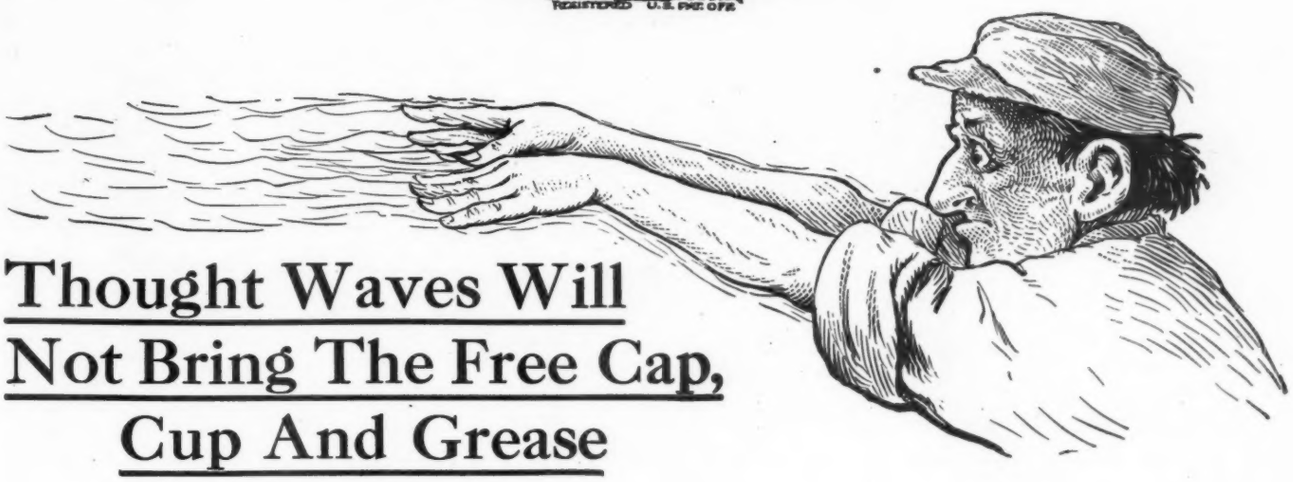

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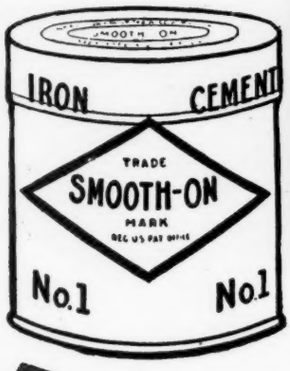

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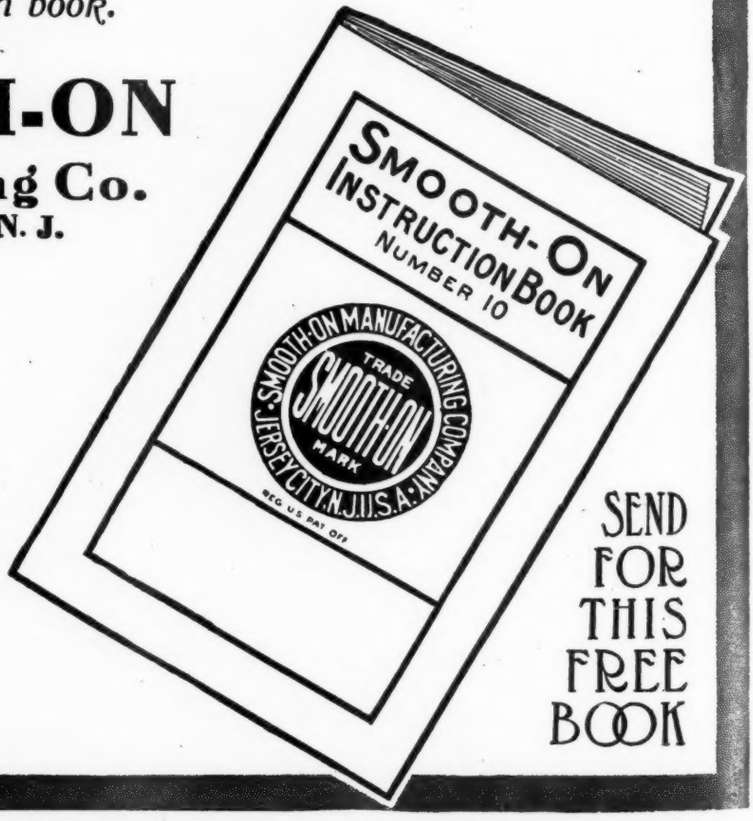

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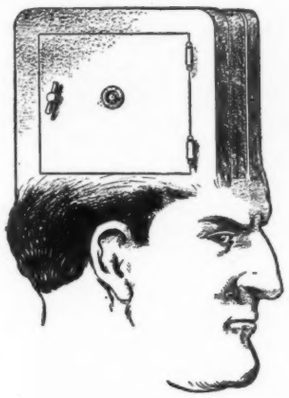
POWER

Vol. 35 NEW YORK, JUNE 11, 1912 No. 24

Hoarding Knowledge Hinders Progress



LIKE money, knowledge is useful only when in circulation. Neither accumulates interest while locked in a safe.

He who keeps to himself the good ideas and useful things he has discovered in practice is either indifferent, mistakenly modest, or selfish. Operating engineering as a whole gains nothing from his work while he refuses to give others the benefit of his experience. Exchange of ideas is essential. Your ideas may help the other fellow, his may help you, and together they will surely help the younger chap still striving to make good.

"Power" the Clearing House

It is the definite scope and particular function of a technical paper to help solve the problems connected with its field and assist all who will be assisted —in short, to be a clearing house for practical, helpful ideas. That is "Power's" fundamental aim.

Ideas do not mean dreams, but suggestions as to how to overcome your fellow engineer's difficulties, what devices have been most effective in accomplishing certain things, why particular methods of operation are best under given conditions and when or where it is wisest to do this or that. Sometimes the description of a practical and efficient installation will indicate a change that will improve another. Short, practical articles are especially desirable. They are read, not laid aside, as are many of the long ones, for future reference. If concise and to the point they are almost certain to be of benefit to the average reader.

The ideal short article sets forth conditions and views of real value, gives valuable data, cites actual and accurate performances which will serve as a guide for other work, or, perhaps most important of all, contains kinks and new ways of doing things that are always helpful.

What to Write About

In choosing a subject do not forget heating and ventilating just because it is summer. Although the plants may now be idle, many things must be done to prepare them for the coming winter.

Refrigeration naturally suggests itself and contributions along this line will be welcome.

The electrical and gas power departments equally deserve your consideration. Practical hints on the operation of gas engines and producer plants, and all kinds of electrical machinery are always timely and we are looking for more material of this character from men who can write with the authority of experience.

If the subjects we have suggested do not appeal to you, then choose your own, but in some way take an active part in furthering power-plant progress. Remember, also, we want your questions and answers to other questions whenever you are minded to send either.

Let "Power" be the Bank of Exchange and use it as it should and would be used. You will get good interest on your investments and add to your own store of knowledge.

Making Charcoal Iron Boiler Tubes*

By George Thomas

History of charcoal iron, its qualities, the method of production and the process involved in the manufacture of boiler tubes.

*From a paper read by George Thomas, treasurer of the Parkesburg Iron Co., at the recent convention of the National Association of American Boiler Manufacturers.

The earliest iron was made by directing a blast of air on a hearth charged with charcoal and finely powdered ore. This crude hearth was later developed into the Catalan forge, which, although the charge has varied, is practically the same and produces the same grade of iron as the sinking fire of today. That the art was highly developed in early times and that the product has lasting qualities, are evidenced by the famous iron pillar of Delhi, a shaft 16 in. in diameter and 23 ft. high, forged about 300 A.D. However, the practice of sinking ore direct is a slow operation, requiring much charcoal, involving a heavy loss and demanding an ore with a very high iron content.

Passing from the Catalan forge, used primarily for reducing ore, next in order is the Lancashire hearth used in Sweden and the United States for converting pig iron. Here an oxidizing flame is used, and the purifying is largely effected by a strongly basic ferruginous slag surrounding the molten particles of iron. In sinking gray iron the pig is melted down before the tuyere, and collects in a slag-surrounded ball at the bottom of the hearth. This mass, not being entirely decarburized, is raised above the tuyere and again remelted through charcoal, when it collects into the final lump or loup.

On account of its lower silicon content, white iron in the Lancashire hearth can be converted in one operation, but on account also of its higher sulphur the product is inferior. To avoid the excessive labor and charcoal costs incident to sinking gray pig iron a preliminary operation was employed, namely, the finery or run-out fire. This consisted of a hearth with four tuyeres, where gray iron was melted in charcoal, the graphitic carbon changed to combined carbon and the silicon greatly lowered. The metal thus formed could be refined in one operation in the Lancashire hearth.

Having in a superficial way followed the conversion of ore and then pig in the forge fire, the conversion of wrought and steel scrap in a hearth of the same character will next be considered. This method of making charcoal iron is today used almost exclusively in America, and to a certain extent in Sweden.

After 1870, through the development of the steel process in this country, very desirable raw material for making charcoal iron was discovered in certain forms of steel scrap. A charge of this material corresponds to the mixture sunk in the Lancashire hearth at the second refining of gray pig iron. There is sufficient carbon to prevent undue oxidization of the iron and sufficient manganese to make a manganiferous as well as ferruginous slag, the first of which is needed to reduce the sulphur and the last to lower the phosphorus in the charge. There is no excess of silicon which in sinking pig iron often caused inferior charcoal iron through making a silicious slag, and consequently preventing the elimination of phosphorus.

In sinking steel scrap, although the charge may run 0.4 per cent. or higher in carbon, 0.6 per cent. manganese, 0.06 per cent. sulphur, and 0.12 per cent. phosphorus; the bloom will average under and will very rarely slightly exceed 0.03 per cent. carbon, 0.025 per cent. manganese, 0.02 per cent. sulphur, 0.04 per cent. phosphorus.

The forge fire usually employed today is run with a cold blast and one tuyere, and much depends on the skill and training of the forgemen. A hot blast saves charcoal and prevents some loss of metal, but it usually produces iron of inferior quality. Two tuyeres work faster and consequently prevent the forgemen from giving proper attention to sinking the mixture. The use of good charcoal, of which about 900 lb. is required to make from scrap a bloom ton of 2464 lb., is

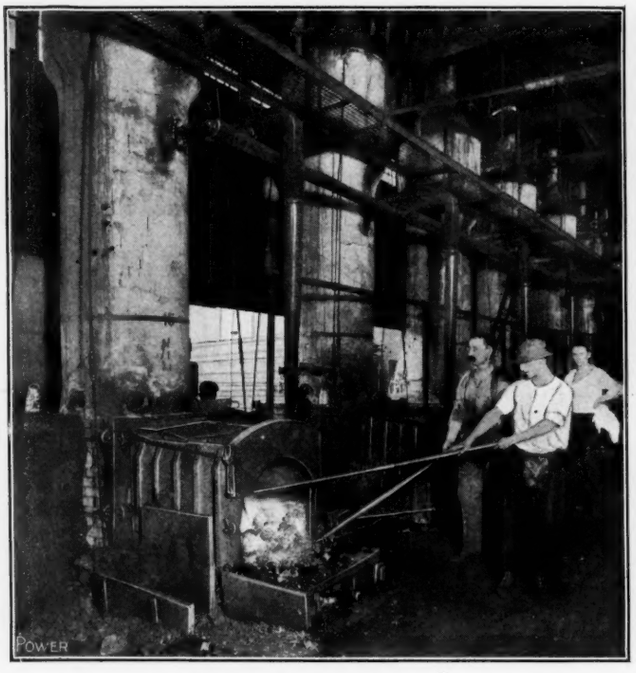


FIG. 1. KNOBBLING FURNACE

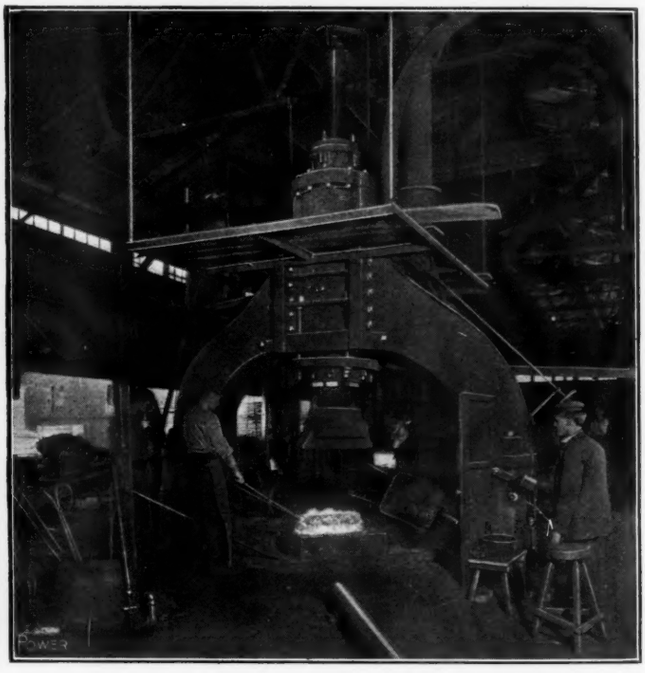
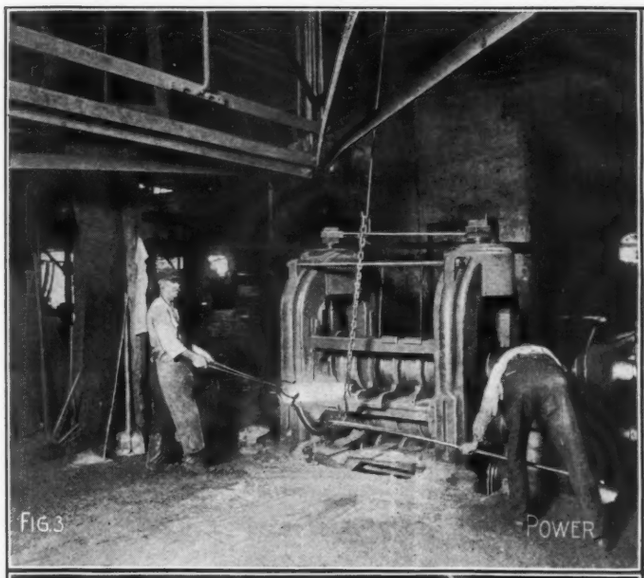
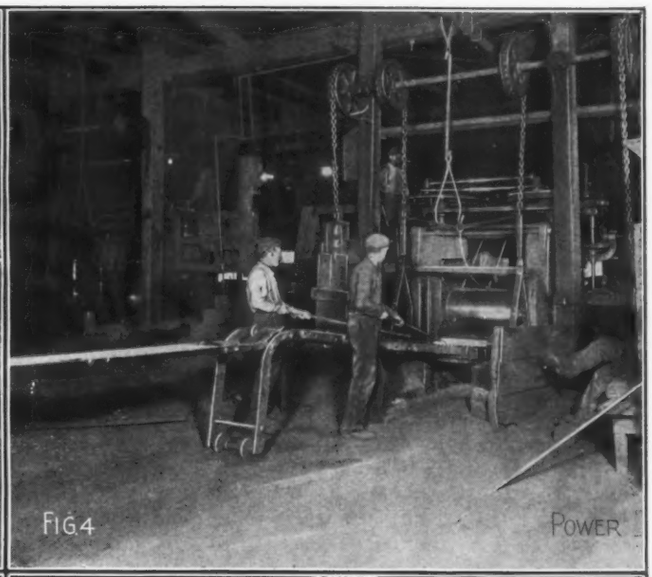
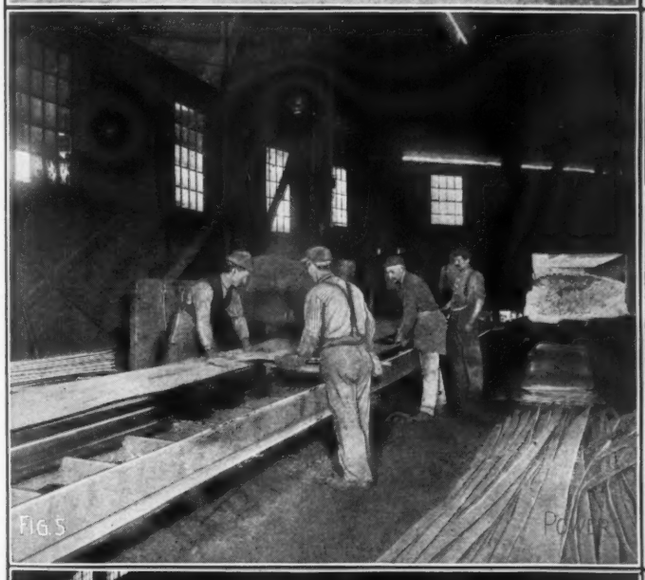


FIG. 2. PLACING LOUP UNDER HAMMER







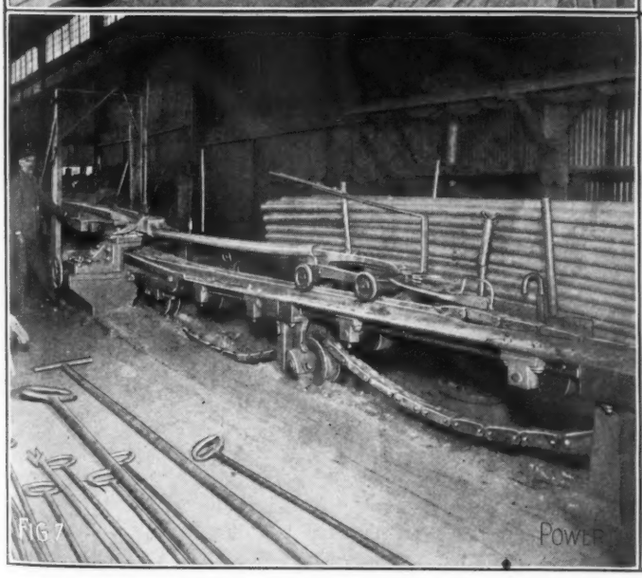


FIG. 3. RUNNING BLOOM THROUGH ROLLS
FIG. 5. TRIMMING PLATE WITH ROTARY SHEARS
FIG. 7. FORMING TUBE FROM SKELP

FIG. 4. TWO-HIGH PLATE ROLLS
FIG. 6. INSERTING PLATE IN FURNACE
FIG. 8. WELDING PROCESS

imperative. The sulphur and silica in coke would in the first case sulphurize the iron; in the latter it would make a silicious or acid cinder with no dephosphorizing power. Charcoal from hard wood, such as maple or hickory, requires a stronger blast and works faster than that from pine or poplar.

Although the production of iron is increasing in England today for employment in bridgework, its main use in America is confined to iron roofing and charcoal-iron boiler tubes.

For boiler tubes, charcoal iron is eminently suited. It is of a fibrous nature, and will not crystallize under shock or vibration; it is ductile, can be beaded easily and securely, and requires little calking; it is preëminently weldable, is noncorrosive and will not pit easily. There are many reasons advanced to account for its noncorrodibility. One is that the intimately mixed network of cinder forms a protective covering, and under acid conditions, cinder being very little affected, this ingredient undoubtedly preserves the life of iron. Another theory ascribes this quality to its homogeneous nature, purity and low manganese, which tend to prevent electrolysis.

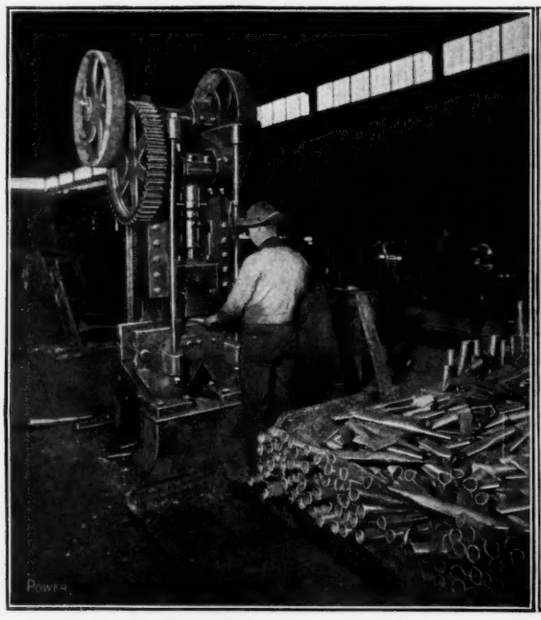


FIG. 9. TESTING TUBE ENDS

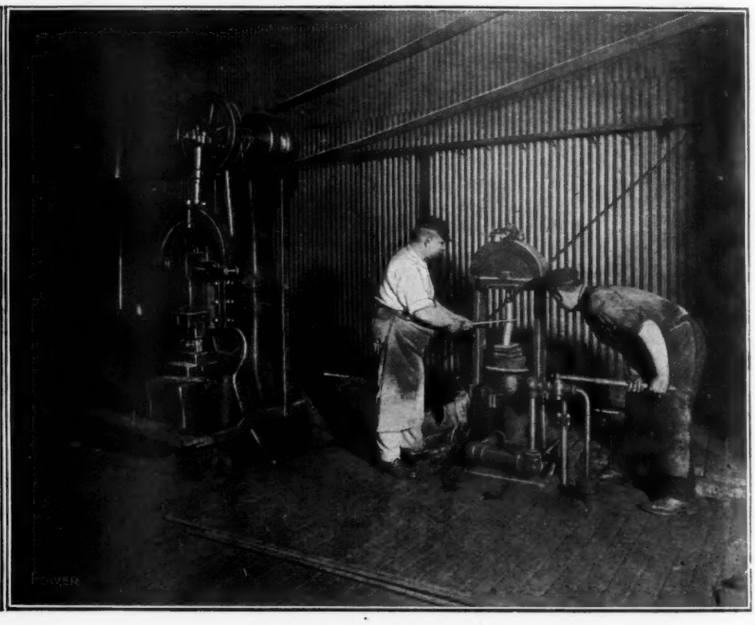


FIG. 10. EXPANSION TEST

PRODUCTION OF BOILER TUBES

The accompanying illustrations show the principal steps involved in the manufacture of charcoal-iron boiler tubes as carried out at the plant of the Parkesburg Iron Co. Incidentally it may be mentioned that it takes about three carloads of charcoal to make 50 tons of charcoal iron.

Fig. 1 is a view of the knobbling fire into which the steel scrap is placed on a bed of charcoal. The furnace consists of four cast-iron plates arranged rectangularly with a tuyere entering upon one side and having a blast pressure of 1½ lb. The plastic metal is worked into a ball or loup which is lifted above the charcoal and is carried to the hammer (Fig. 2) under which much of the cinder is eliminated, the slag on the outside is knocked off and the loup formed into a bloom.

From the hammer the bloom is taken to the rolls (Fig. 3) where in three passes it is run into a bar. These bars are cut to length to make a pile of the proper weight and the piles are heated in a draft furnace. The best practice at this stage of the process is to employ an old-fashioned draft furnace, as a blast furnace is liable to blow dust in between the bars and make blisters.

Fig. 4 is a view of the plate rolls where at a welding heat the pile of bars is given several lateral passes to secure the proper width and cross-fiber. It is then rolled lengthwise to the gage desired.

After cooling, the plates are marked to the proper size and are then run through rotary shears where the skelp is cut to the proper width. This operation is shown in Fig. 5. This skelp is then carefully inspected and any strip that is found defective is not sent to the tube mill.

After being inspected, the strips of skelp are put into the bending furnace (Fig. 6), heated to a red heat and drawn out through a door into the scarfing rolls located at the end of the furnace. The strips go through the rolls, which have a bevel at each edge to give the scarf to the skelp; and are then drawn through dies which form them into cylindrical shapes with the scarfed edges overlapping. Fig. 7 shows a tube going through the dies.

The next step in the process is welding the scarfed edges of the bent skelp. For this purpose the skelp is introduced into a furnace where it is raised to a welding heat. It is then pushed out of the furnace and into the welding rolls shown in Fig. 8. There is a ball on the end of the rod which is placed between the two concave surfaces of the rolls and the pressure exerted on the bent skelp as it goes through the rolls is sufficient to secure a weld. The tube is given two welding heats and goes through the welding rolls twice to insure a weld.

After this the tube is passed through size-rolls which give it a true cylindrical form. Passing then to the cross rolls the tube is straightened and the scale is knocked off, after which it goes through a trough and is finally transferred to the cooling rack. This rack is operated at different speeds, depending upon the sizes of the tubes so as to secure the proper heat treatment in cooling.

The tube next goes through a straightening press (a supplementary process to the cross rolls) in order to insure its being absolutely straight. Then after a rigid inspection the ends of the tubes are sawed off to give them the proper length and these ends are tested for crushing in a press. This operation is shown in Fig. 9. An imperfect weld will be detected by this means and the tube from which the end has been sawed is scrapped.

If the tube passes this test the ends are reamed and the burrs from the saw are taken off. As this may make the tube a little thinner at the ends, another inspection is made in which the ends are gaged and the surfaces carefully looked over.

The tubes now have to undergo a hydrostatic pressure test of 500 lb. per square inch and in some cases 1000 lb.

As an additional precaution, the tubes are tested for expansion. This consists, as shown in Fig. 10, of placing one of the sawed-off ends into a 50-ton press. A conical pin is inserted in one end and the pressure applied until the tube has expanded to 1⅛ times its original diameter without showing any signs of rupture. Furthermore, the ends are beaded to make sure that the metal is ductile. In addition to these physical tests the raw material is subjected to a chemical analysis before going to the forge fire.

For some classes of service such as with locomotives, some railroads require that the ends of the tubes have a different gage from that of the bodies. In such a case the safe-end is ¼ in. larger in diameter than the body of the tube. This is pushed over the end of the tube, brought to a welding heat in a safe-ending furnace and then drawn down under a hammer to the exact diameter of the tube.

Acton Corliss Balanced Stop Valve

There are various types of automatic stop valves used on steam-engine and boiler connections, one of which is a balanced Corliss valve, manufactured by John Acton, 118 John St., Brooklyn, N. Y. It is illustrated in detail in Fig. 1.

There are several methods of arranging this valve to operate either by hand or automatically. One installation is in the engine room of the Chelsea Fibre Mills, Greenpoint, N. Y., the arrangement for controlling the action of the valve having been worked out by Chief Engineer Leak. The valve is located in the horizontal steam line just inside the wall between the boiler and the engine

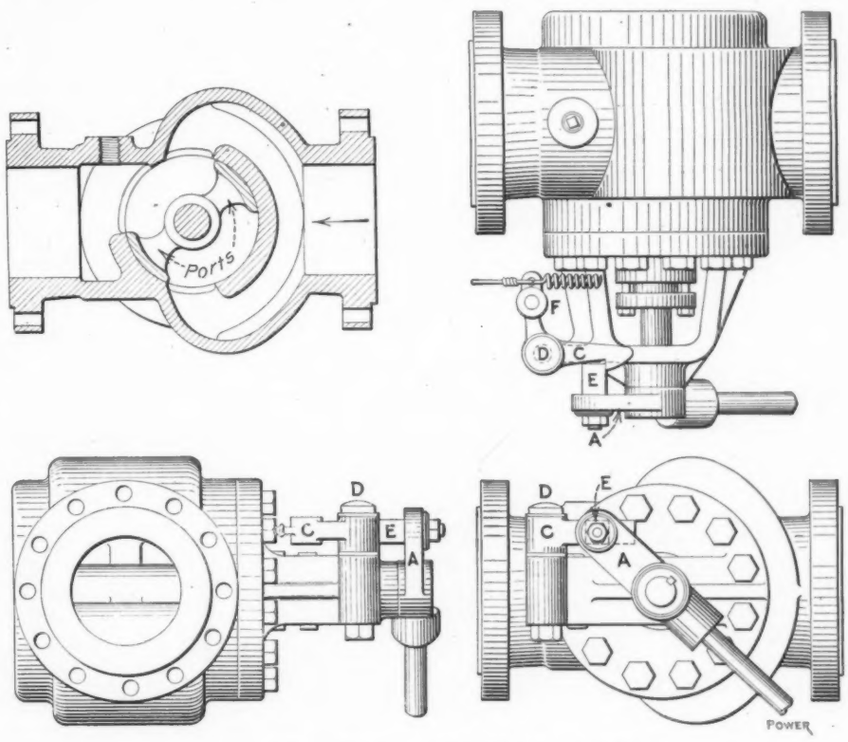


FIG. 1. ACTON BALANCED CORLISS STOP VALVE

rooms, as shown in Figs. 2 and 3, and controls both of the main engines which are of 1000 and 1200 hp. capacity.

The valve stem is fitted with a lever *A*, Fig. 4, in one end of which is a square steel stud and in the other an extension rod. A boss is cast on the valve bonnet which carries a dog *C*, pivoted at *D*. The dog is held in a position to engage the stud by a spring *F*, Fig. 1, which is attached to a projection on the dog. A cord is also run to the weight *G*, with extensions dropping to within the reach of the operator.

The angle lever *H* works in bracket bearings and is connected to the lever *A* by a rod. The weight *J* and dashpot plunger are suspended from the short end of the angle lever by an iron rod.

Each engine drives a speed-limit device consisting of a small throttling governor, the valve disk and seat of which have been removed. The valve stem is cut to a suitable length and operates a relay arm which is pivoted at *K*, the bottom end of the arm being fitted with a platinum contact point. The two contact blocks are connected to the relay coil *L*, which, in operating, closes the 110-volt circuit to the magnet *M*. The magnetism set up in the coil draws the armature away from the weight *G* which on becoming disengaged drops, breaking the circuit at the contact *O*.

The speed-limit governor is speeded five to one; that is, for each increased revolution in engine speed, the governor speed increases five revolutions. As the rim of the driving wheel travels 5800

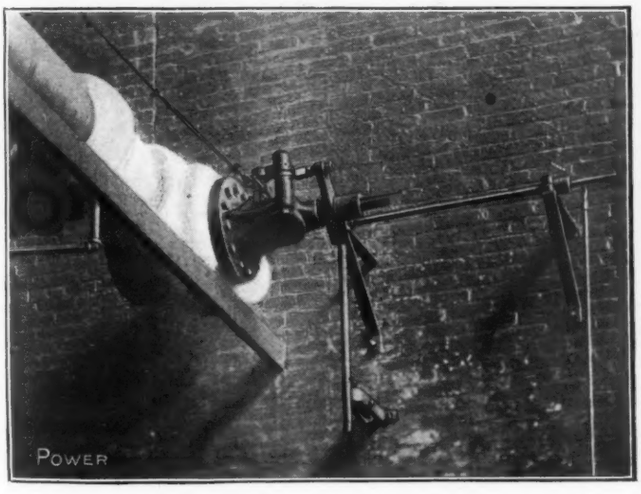


FIG. 2. VALVE OPEN

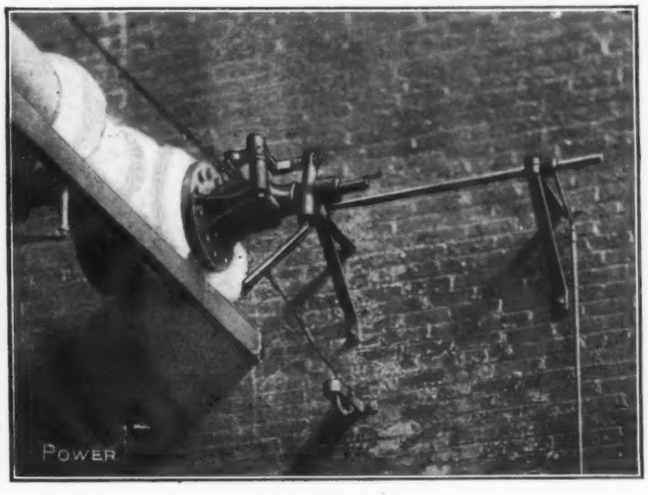


FIG. 3. VALVE CLOSED

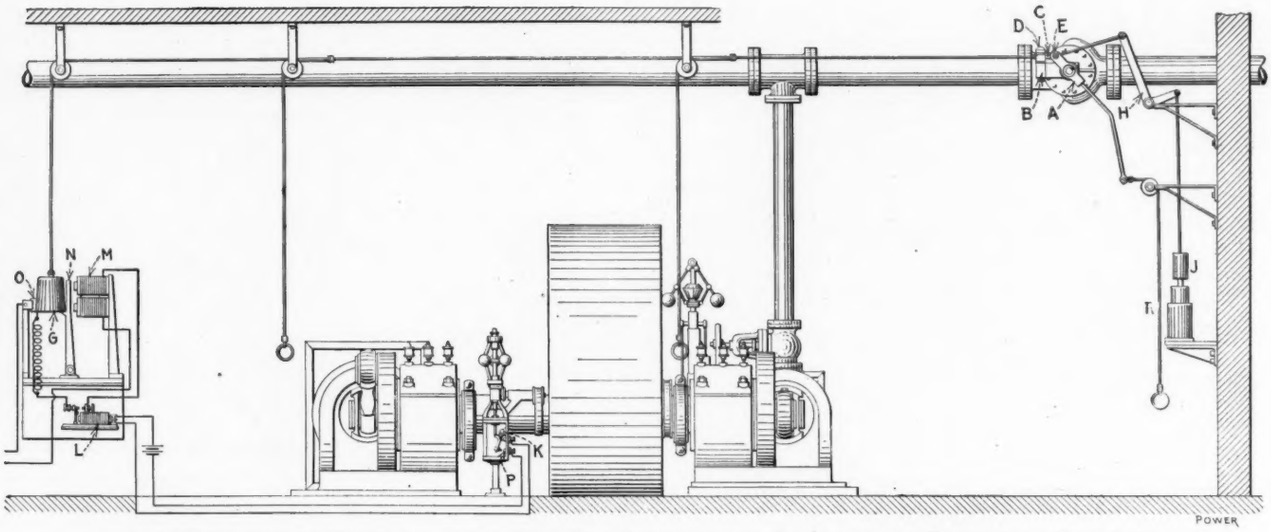


FIG. 4. ELEVATION OF VALVE AND AUTOMATIC STOP ARRANGEMENT APPLIED TO AN ENGINE AND PIPE LINE

ft. per minute, Engineer Leak has adjusted the governor so that with an increase of three revolutions of the engine above normal, the governor closes the circuit at *P* and steam is shut off from both engines by the automatic stop valve.

When the weight *G* falls, it pulls the dog *C* away from the catch block *E*. This releases the valve stem and the weight *J* pulls the valve forward. The dashpot below the weight *J* is to prevent the valve from closing with a slam.

The stop valve is closed in the same way when any one of the hand ropes is pulled, releasing the dog from the catch block.

After the valve has operated it is set in an open position by pulling down on the rope *R*, which moves the lever toward the right and latches the catch block with the dog *C*.

Before the governor acts a second time, the weight *G* must be reset on the armature *N*, which movement also closes the 110-volt circuit at the contact *O*. The device is then ready for service should the engine again exceed the normal speed limit.

Circulation Test of Robb-Bradv Scotch Boiler

The claims for positive circulation made by the builders of this boiler were thoroughly tested recently at the sewage pumping station, Framingham, Mass. The Robb-Brady boiler at this plant was equipped with thermometer oil wells so that the temperature could be noted at four points: at the top of the shell near the front end, at the top of the shell, at the rear just over the combustion chamber, at the front and rear close to the bottom, as shown in Fig. 1.

With water in the boiler at about 80 deg. F., the fires were started and readings of all thermometers taken every

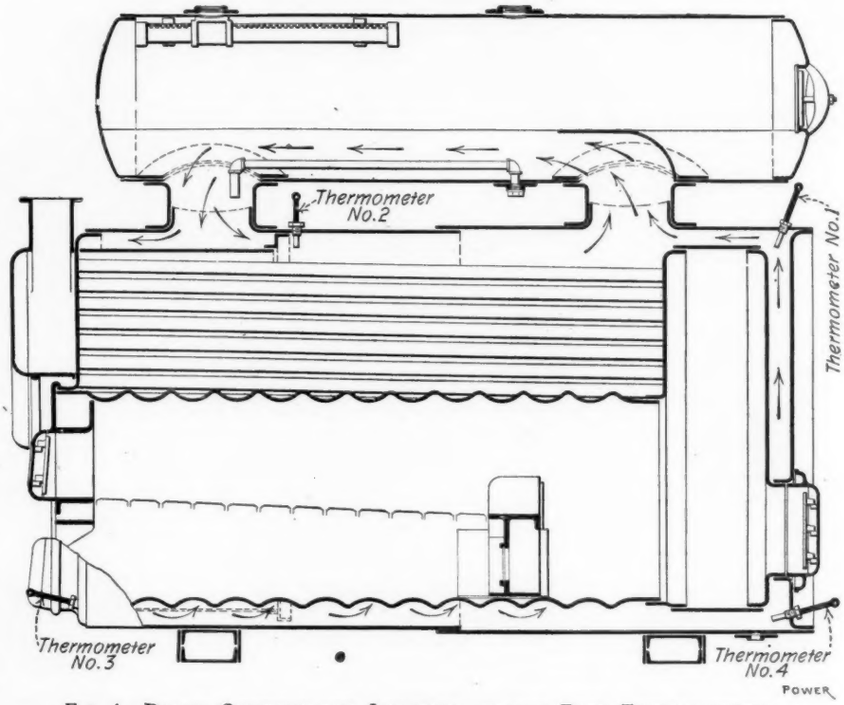


FIG. 1. BOILER SHOWING THE LOCATION OF THE FOUR THERMOMETERS

TEMPERATURE TEST, 50-HP. ROBB-BRADY SCOTCH BOILER, MARCH 31, 1912

Framingham Sewage Pumping Station, Framingham, Mass.

Time P.M.	Thermometer No. 1 On Top of Boiler at Rear End, Deg. F.	Thermometer No. 2 On Top of Boiler at Front End, Deg. F.	Thermometer No. 3 At Bottom of Boiler at Front End, Deg. F.	Thermometer No. 4 At Bottom of Boiler at Rear End, Deg. F.
3:40	114	112	80	82
3:45	126	124	80	82
3:50	138	140	80	83
3:55	150	150	81	84
4:00	170	170	82	86
4:05	194	190	84	87
4:10	210	210	98	90
4:15	226	224	210	136
4:20	231	230	226	180
4:25	244	242	234	230
4:30	258	260	252	248
4:35	276	278	268	270
4:40	292	292	292	290
4:45	310	308	306	310
4:50	328	330	328	328
Safety Valve Blowing off				
4:55	330	330	328	330
5:00	327	328	327	327

five minutes. As was expected, the temperature of the water at the top of the shell increased steadily until the boiling point was reached. At the bottom, the temperature increased very slowly up to the time the upper thermometer indicated the boiling point. Then the lower thermometers showed a sudden rise, jumping to within a few degrees of those at the top. From this time on all four kept within a few degrees until 100 lb. pressure was reached, when practically no difference could be noted at the four points, showing conclusively that the circulation was positive and rapid. The accompanying curve, Fig. 2, gives graphically the thermometer readings at five-minute intervals. The table gives the readings of the four thermometers during the test. A description of this boiler appeared in POWER, July 11, 1911, page 76.

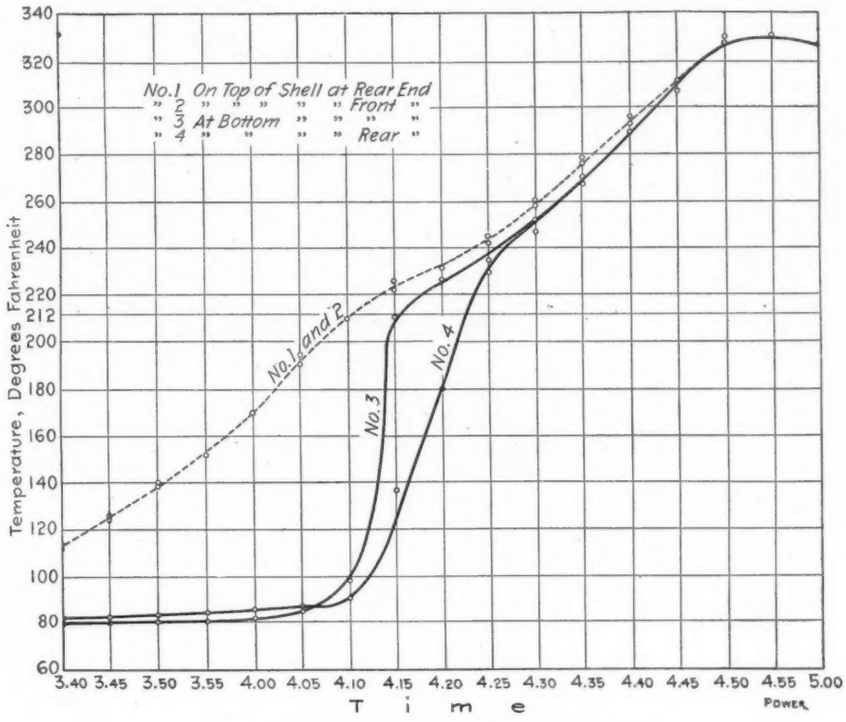


FIG. 2. CURVES OF THERMOMETER READINGS

The test was witnessed by many prominent consulting and operating engineers and the representatives of several boiler-insurance companies.

Old Sawmill Boiler Explodes

On May 18, a boiler of the locomotive type with a 30-hp. engine mounted on top, exploded in the sawmill of John de Frain, East Vincent, Chester County, Penn. Two men were killed and three injured and a property damage amounting to about $1000 resulted.

The boiler, which was 31 years old, was 10 ft. long and contained sixty-five 2-in. tubes. The joints were single-riveted, pitch 2 in. The working pressure was 65 to 75 lb. and the safety valve was set at 80 lb.

The boiler, minus the furnace, was blown endwise out of the building, demolishing the roof entirely and landing 50 yd. away. Eighteen of the tubes were strewn along the path taken by the boiler. Two weeks previous a boiler maker inspected the boiler and claimed that it was in excellent condition. Just before the accident the water glass showed that the boiler contained 2½ gages of water so that it is necessary to look elsewhere for the cause of the explosion.

Apparently the initial rupture occurred in the crown-sheet. This was found to be less than ⅜ in. thick and a bad lamination showed up in the plate.

At the coroner's inquest it was brought out in the evidence that the crown-sheet was badly rusted on both sides. A piece of metal was produced which had been twisted out from the sheet with the fingers of the man giving the testimony. It was in bad condition and had been taken from a point very near the safety plug which was still in perfect order.

The boiler-feed water was drawn from a spring and there was no evidence of scale or oil having found its way to the surface of the sheets. A gradual deterioration during the 30 years of service had probably weakened the crown-sheet to the point of failure which occurred when blowing down the boiler.

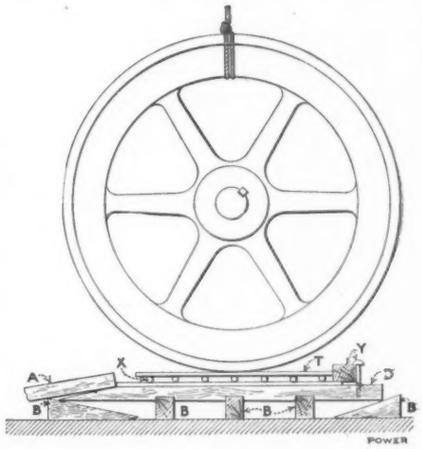
BOILER MINUS FURNACE SEVERAL HUNDRED FEET FROM SETTING

Removing a Heavy Flywheel

BY L. S. DURMON

While operating as night engineer in a small electric-light and power plant, located in an isolated and sandy part of South Dakota, the writer experienced trouble with a hot main bearing on one of the engines.

The engines were of the internal-combustion, two-stroke-cycle type, and it was undoubtedly the suction of the intake that drew sand into the engine, where it finally found its way to the bearing, causing it to heat. After running about an hour the bearing became so hot that it was necessary to shut down the engine. The bushing was of the usual cylindrical form and slipped on over the shaft, to remove which it was necessary to remove the flywheel. I was alone, with no telephone to summon aid, but as the plant furnished 24-hr. service, something had to be done; I decided to do the job single-handed.



SHOWING METHOD OF BLOCKING THE WHEEL

Some pieces of sheet iron about 3 ft. square and ⅜ in. thick, some ball bearings, a short piece of rope, a number of planks and blocks, and a crowbar completed the outfit for the removal of the flywheel.

The wedges *B* in the accompanying illustration were made of oak. The plank

D was placed under the wheel and one of the plates laid upon it. On top of the plate the balls *X* were placed, and on top of these was laid the plate *T*. The wedges were then driven in until the plates took the weight of the wheel. The key was then withdrawn and the wheel worked back and forth until it came off the shaft. A short piece of rope was fastened to the top of the wheel to prevent it from tipping over.

After the wheel was taken off the shaft the lag screw and block *Y* were placed in position to prevent the wheel from rolling backward when it was being rolled on the plank *A*. The bushing was then removed and put back on the shaft in a reverse position, after which the wheel was rolled up the plank with a crowbar and replaced on the shaft. The job required about five hours to complete, but, considering the condition, the time was really short.

American Type of Uniflow Steam Engine

In 1872 an American patent was granted on an improvement in reciprocating steam engines consisting of an opening through the bottom of the cylinder wall at or near the middle of its length. Toward the end of its stroke the piston uncovered the opening, allowing the water and the steam not exhausted through the valve-controlled port at the top of the cylinder to discharge at the bottom. This seems to have been the forerunner of the uniflow design, although the inventor did not realize the advantages of widely separating the admission and exhaust valves, or he would have omitted the other and used the central exhaust port entirely.

Years later, L. J. Todd evidently recognized the value of the uniflow principle. He developed a design based on it and in 1886 took out English patents. Apparently Mr. Todd did not push the practical application of this principle to any great extent. The credit for this belongs to Prof. Stumpf, of Charlottenburg, Germany, whose engine, built on this principle, has attained commercial success. The Stumpf uniflow engine, which was fully described in POWER, Jan. 31, 1911, and mentioned in still earlier issues, is equipped with poppet valves, conforming with German practice.

The Nordberg Manufacturing Co., Milwaukee, Wis., is the pioneer in developing the uniflow principle in America. This company built a uniflow engine early in 1911 and set it up with separate surface condenser, air pump, electric generator, water rheostat and all equipment necessary for complete and accurate testing. Over 100 complete tests were made with different steam pressures, vacuums and speeds. Corliss valves were adopted as more in accord with American practice and familiar to practically all operating engineers. The gear used was specially designed for this engine's speed and service requirements.

The uniflow engine derives its economy through largely reducing the loss due to initial condensation. In a four-valve cylinder one face of the piston and the corresponding cylinder head are exposed to the exhaust temperature almost throughout each stroke, or 90 per cent. or more of the time. The admitted steam meeting these large cooler surfaces is partly condensed, and while some may be reëvaporated toward the end of the stroke, there is still a considerable heat loss.

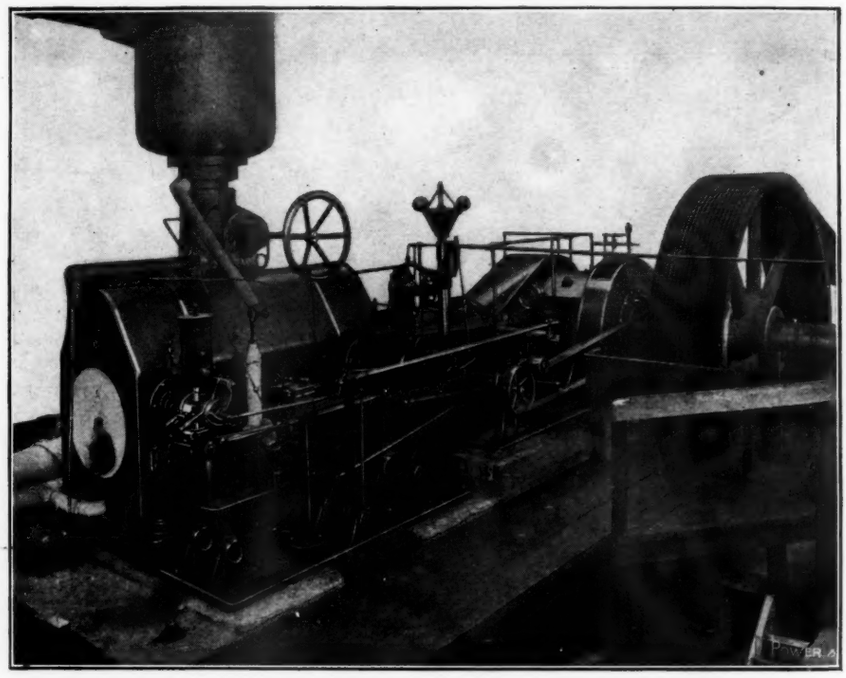


FIG. 1 EXPERIMENTAL ENGINE ON TESTING BED

Unlike the four-valve engine, the uniflow engine's piston faces and cylinder heads are exposed to exhaust temperature only the short time the piston uncovers and again covers the exhaust ports. On the return stroke the steam remaining in the cylinder is compressed in the clearance space up to admission pressure. The temperature also increases each stroke, so that in effect the piston is the exhaust valve. The two steam valves *A* are in the cylinder heads, and the steam spaces over the valves with the clearance pockets *B* completely steam-jacket the heads.

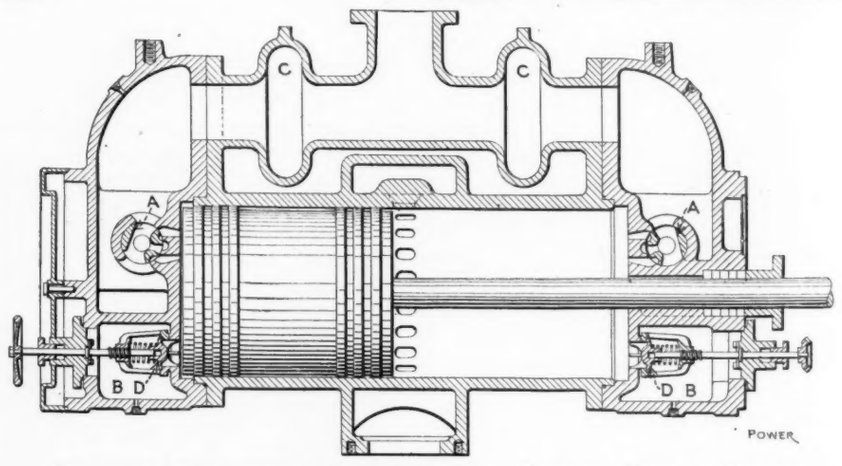


FIG. 2. SECTION THROUGH CYLINDERS OF THE NORDBERG UNIFLOW ENGINE

A view of the valve-gear side of the experimental uniflow engine on the testing floor is given in Fig. 1. Fig. 2 shows a section through the cylinder. This cylinder has no exhaust valves, but in its middle is a ring of ports which are uncovered by the piston at the end of each stroke, so that in effect the piston is the exhaust valve. The two steam valves *A* are in the cylinder heads, and the steam spaces over the valves with the clearance pockets *B* completely steam-jacket the heads.

The cylinder, Fig. 2, is a simple cylindrical casting with a belt cast in the middle for the exhaust passage. The steam

chest is integral with the cylinder and provided with two drums *C* to take up expansion without distorting the cylinder.

Each end of the cylinder has a large valve *D* opening into a pocket *B* in the

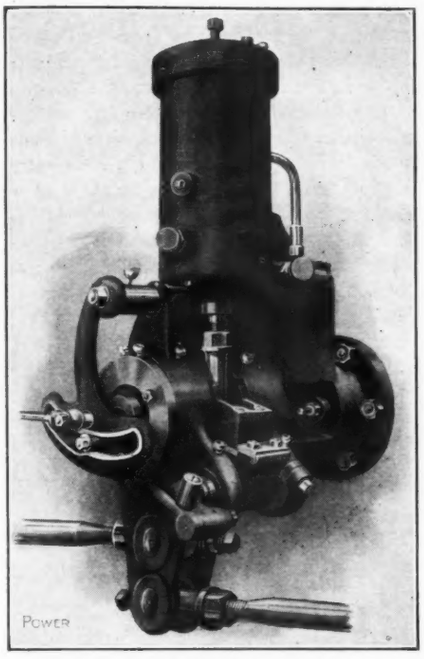


FIG. 3. VALVE MECHANISM

cylinder head. Opening automatically, these serve both as large relief valves to let out entrained water and extra clearance to prevent excessive compression if the vacuum is lost when running condensing. If the engine is to run continuously noncondensing, the valves may be held from their seats to increase the clearance by the volume of the pocket.

The piston is of the block type and is provided with three snap rings at each end. The Nordberg patent four-ported steam valves give a large opening with a small movement of the valve so that the actual feet of travel which determines the wear are no greater with these valves when running at 150 r.p.m. than with single-ported Corliss engine valves running at half the speed.

The valve mechanism, Fig. 3, is especially designed for high speed and hard service. Unlike the standard Corliss gear, the steam arm is not supported on the valve stem, but on a large bearing extended from the steam bonnet. This arm has two bearings for the hook, one on each side of a central plane with respect to which the entire gear is symmetrical, and there are no overhung parts or side strains. The steel trip blocks are exceptionally wide and the dashpots are of the spring type to insure positive action at high speed. The valve stems have two bearings in the bonnets. The cutoff gear gives any point of cutoff from zero to eight-tenths stroke under full control of the governor without distorting the valve motion, so that positive lap is retained and the valves open at maximum speed.

Figs. 4 and 5 show typical indicator diagrams and Figs. 6 and 7 the economy attained by this engine under 150 lb. initial pressure and ½ lb. back pressure, running noncondensing and under 160 lb. initial pressure and 26 in. of vacuum running condensing. The speed was 150 r.p.m.

This engine is remarkable for its great overload capacity and its flat steam-consumption curve. Fig. 7 shows that the engine will take an overload of 100 per cent. with an increase in steam consumption per horsepower-hour of about 10 per cent.

The engine is particularly adapted to rolling-mill service, street-railway and lighting work and general power purposes where the load is subject to wide fluctuations; that is, where the load factor is low.

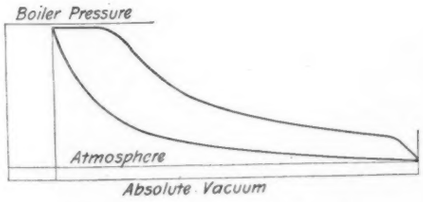


FIG. 4. NONCONDENSING DIAGRAM

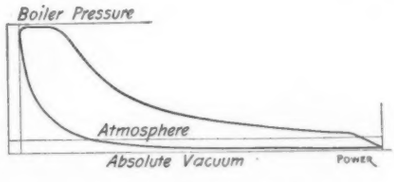


FIG. 5. CONDENSING DIAGRAM

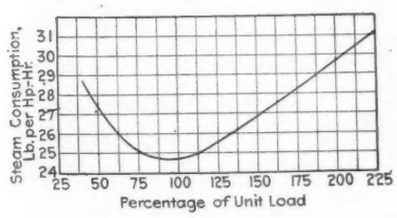


FIG. 6. NONCONDENSING ECONOMY CURVE

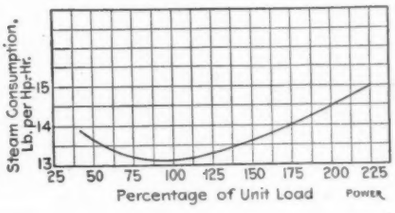


FIG. 7. CONDENSING ECONOMY CURVE

Economy Tests of Steam Turbines

The table herewith is part of a paper on the "Present State of Development of Large Steam Turbines," read at the spring meeting of the American Society of Mechanical Engineers by Prof. A. G. Christie, of the University of Wisconsin. With regard to this phase of the subject he says:

The efficiency of a steam turbine may be expressed in terms of pounds of steam per kilowatt-hour, as an efficiency ratio or as the B.t.u. required per kilowatt-hour.

The steam consumption is dependent on the initial steam pressure, its temperature or quality, and the condenser pressure. These factors vary in almost every test and the effect of a variation in each is not the same for all classes of turbines. Hence, different turbines cannot usually be compared satisfactorily on the basis of their steam consumption alone.

If the steam could expand freely to exhaust pressure in a turbine without radiation, friction, eddy or windage losses, its expansion would be adiabatic and on the Rankine cycle. The "efficiency ratio" expresses the proportion of the heat actually turned into work to that available from such an adiabatic expansion; in other words, it expresses the efficiency of the actual turbine as compared to the ideal turbine, and is independent of the type of turbine.

The B.t.u. per kilowatt-hour is figured above the heat of the liquid at exhaust pressure. This is not a satisfactory standard by which to compare results, for it is largely dependent on conditions beyond the control of the turbine builder. For instance, if the plant does not contain superheaters, the B.t.u. per kilowatt-hour will be high. The same will be true of a plant which has a warm cooling-water supply for condensers and consequently carries low vacuum. Yet the turbines may be designed to give a high efficiency ratio under these conditions. In fact, they may be able to utilize the heat available more efficiently than the turbines in another plant with both high superheat and high vacuum.

This can be seen in the accompanying tabulation of recent turbine results. The Brown-Boveri turbine at the Dunstan power plant uses 14,980 B.t.u. per kilowatt-hour with an efficiency ratio of 68.8 per cent. Yet the Westinghouse City Electric, with a lower steam pressure, superheat and vacuum, has an efficiency ratio of 68.9 per cent., though using 16,925 B.t.u. per kilowatt-hour. The Erste Brünner Vienna turbine requires 16,460 B.t.u. per kilowatt-hour with 71.8 per cent. efficiency ratio. It is therefore apparent that the efficiency ratio alone will express in the best manner the de-

gree to which the designer has approached ideal results in his turbine.

The test results in the table were grouped in order to analyze the relative merits of the different types of turbines on the basis of efficiency ratios. The Curtis-Parsons machines built by Erste Brünner hold first place in the list, but are followed closely by others of the same type built by Brown-Boveri and Westinghouse Machine Co. The Parsons turbines built by Allis-Chalmers and Brown-Boveri also show high efficiencies. The second class in the order of efficiency includes turbines of the Curtis-Rateau and Curtis-Zoelly types, among which the turbines of the A. E. G. and British Westinghouse Co. show remarkably good results. The next group includes simple Zoelly and Rateau turbines. The last group comprises straight Curtis types.

The superiority of the Curtis-Parsons over the Parsons type is probably due to the reduction in the fluid friction and rotational losses occurring in the first cylinder of the Parsons by the use of a Curtis stage in this section.

The Parsons low-pressure sections evidently utilize the heat in the steam only slightly more efficiently than do the impulse turbines. The great surface areas of all disk-type turbines which must be whirled in steam, produce losses which are apparently somewhat larger than the combined whirling losses and leakage in the Parsons drum turbines. Both the Zoelly and Curtis-Rateau types appear to use the steam more effectively in the low-pressure sections than the Curtis alone. Many European engineers hold the opinion that where high economy is to be obtained, the impulse turbine of the Rateau or Zoelly type is superior to the Curtis, though its manufacturing costs are higher. The Curtis-Rateau construction has all the commendable features of impulse turbines and has proved very economical.

The results in the table are from the best reliable tests that have been made on each type. Objections may be raised that these results do not represent actual operating conditions as under varying loads, nor the average economy of any type of turbine. For instance, the Curtis turbine usually gives a very flat water-rate curve, while the Parsons type is more convex. On the other hand, recent tests on the new Curtis-Parsons types have also shown flat water-rate curves at various loads. It was impossible to compare the various types from this standpoint on account of absence of complete data of such tests.

It is interesting to note that the best results have been obtained within the past two years and that these show a considerable increase in efficiency over the earlier turbines.

ECONOMY TESTS OF HIGH PRESSURE STEAM TURBINES

Efficiency Ratios Based on E.H.P. Marks & Davis Steam Tables Used

Maker of Turbine	Type	Date of Test	Load-Kw.	R.p.m.	Steam Pressure, Lb. Absolute	Temperature at Throttle, Deg. F.	Vacuum Referred to 29.92" Bar.	Condenser Pressure, Lb. Absolute	Lb. of Steam per Kw.-hr.	B.t.u. per Kw.-hr.	Heat Utilized per Lb. of Steam	Heat Available per Lb. of Steam	Efficiency Ratio	Reference
Erste Brünner M. F. G.	Curtis-Parsons	1910	2,128	1500	156.2	482	27.89	0.995	13.82	16,460	247.0	343.8	71.8	*Periodische Mitteilungen*
Erste Brünner M. F. G.	Curtis-Parsons	..	6,000	960	184.9	573	28.18	0.854	12.56	15,570	271.5	380.7	71.3	*Zeit. D.V.D. Ing.*, 12/10/'10
Erste Brünner M. F. G.	Curtis-Parsons	1910	7,442	960	192.0	584	28.18	0.853	12.625	15,705	270.2	384.4	70.3	*Periodische Mitteilungen*
Westinghouse Machine Co.	Curtis-Parsons	1910	9,173	1800	181.7	433	27.81	1.032	14.57	16,925	234.1	340.2	68.9	*Trans. A.S.M.E., vol.* 32
Brown-Boveri & Cie.	Curtis-Parsons	..	3,053	1360	150.2	505	29.00	0.456	13.01	15,990	262.2	385.5	68.0	*Dinglers P.J.*, 6/17/'11
Erste Brünner M. F. G.	Curtis-Parsons	1910	1,416	1260	128.2	482	27.60	1.137	15.18	18,060	224.6	326.5	68.8	*Periodische Mitteilungen*
Brown-Boveri & Cie.	Curtis-Parsons	1911	1,750	1500	176.4	586	27.08	1.392	14.23	17,500	239.5	354.8	67.5	*Zeit. F.D.G. Turb.*, 5/30/'11
Brown-Boveri & Cie.	Curtis-Parsons	1910	3,764	1500	161.2	561	28.77	0.562	13.04	16,290	261.5	391.4	66.8	*Zeit. F.D.G. Turb.*, 5/30/'11
Westinghouse Machine Co.	Curtis-Parsons	..	9,830	750	192.2	475	27.22	1.322	15.15	17,790	225.2	336.0	67.0	*Trans. A.S.M.E., vol.* 32
Brown-Boveri & Cie.	Curtis-Parsons	1911	1,495	3000	200.6	563	26.41	1.720	14.78	17,880	230.7	345.5	66.8	*Data from Manufacturer*
Brown-Boveri & Cie.	Curtis-Parsons	1911	1,271	3000	172.1	568	27.31	1.278	14.61	17,880	233.5	354.3	65.9	*Data from Manufacturer*
Westinghouse Machine Co.	Curtis-Parsons	..	11,466	750	191.7	484	28.07	0.910	14.45	17,210	236.0	360.5	65.5	*Trans. A.S.M.E., vol.* 32
Erste Brünner M. F. G.	Curtis-Parsons	..	1,250	3000	184.9	573	27.89	0.996	14.32	17,680	238.2	373.1	63.9	*Zeit. D.V.D. Ing.*, 12/10/'10
Brown-Boveri & Cie.	Curtis-Parsons	1910	3,320	1500	180.9	525	29.02	0.440	13.50	16,680	252.7	401.3	63.0	*Zeit. F.D.G. Turb.*, 5/30/'11
Brown-Boveri & Cie.	Curtis-Parsons	..	5,128	1000	171.2	565	28.52	0.726	14.35	17,830	237.7	382.9	62.1	*Stodola, 4th ed., p.* 449
Breitfield, Danek & Co.	Impulse Parsons	1909	3,585	896	160.7	457	28.32	0.782	16.08	19,070	212.0	352.4	60.2	*Zeit. D.V.D. Ing.*, 12/10/'10
Brown-Boveri & Cie.	Parsons	1910	6,257	1210	203.7	559	29.02	0.440	11.95	14,980	285.5	415.0	68.8	*Official Test Report*
Allis-Chalmers	Parsons	1908	4,300	1800	186.4	484	27.96	0.960	14.02	16,690	243.4	355.7	68.4	*Sibley Jour. of Eng.*, 1/'11
Brown Boveri & Cie.	Parsons	1903	3,500	1360	156.4	499	28.84	0.532	13.71	16,720	248.5	378.6	65.6	*Zeit. D.V.D. Ing.*, 12/10/'10
Brown-Boveri & Cie.	Parsons	..	3,000	1360	165.0	625	27.02	1.420	14.75	18,433	231.3	359.5	64.3	*Die Turbine*, 6/20/'11
C. A. Parsons & Co.	Parsons	..	5,164	1200	214.3	509	28.95	0.473	13.18	16,140	258.7	402.3	64.3	*Stodola, 4th ed., p.* 439
Allis-Chalmers	Parsons	1911	3,850	1800	164.7	491	27.91	0.983	15.40	18,410	221.3	348.3	63.5	*Power*, 1/2/'12
A. E. G.	Curtis-Rataeu	1911	6,518	1220	198.7	601	29.28	0.352	11.43	14,640	298.4	434.2	68.7	*Official Test Report*
A. E. G.	Curtis-Rateau	1911	6,565	1220	200.2	597	29.18	0.406	11.64	14,848	293.0	427.7	68.5	*Official Test Report*
British Westinghouse	Curtis-Rateau	1911	5,066	1500	190.2	552	28.68	0.649	13.00	16,100	262.4	391.5	67.0	*Electrical Review*, 6/23/'11
M. A. N.	Curtis-Zoelly	..	3,584	1500	178.3	569	27.54	1.166	13.99	17,190	243.7	361.3	67.5	*Data from Manufacturer*
Bergmann	Curtis-Rateau	1909	1,545	1500	188.5	581	28.59	0.654	12.97	16,230	263.0	396.3	66.4	*Zeit. D.V.D. Ing.*, 12/10/'10
Bergmann	Curtis-Rateau	1910	2,477	1500	140.0	522	28.81	0.588	13.93	17,135	244.8	373.4	65.6	*Elec. Zeit.*, 4/20/'11
A. E. G.	Curtis-Rateau	1908	4,239	1500	188.3	662	29.11	0.397	11.97	15,620	284.9	439.0	64.9	*Stodola, 4th ed., p.* 404
British Westinghouse	Curtis-Rateau	1911	2,930	1500	210.2	568	28.18	0.894	13.72	16,935	248.7	383.3	64.9	*Electrical Review*, 4/28/'11
A. E. G.	Curtis-Rateau	1907	3,169	1500	184.7	592	29.11	0.397	12.74	16,230	267.7	425.1	63.0	*Trans. A.S.M.E., vol* 32
M. A. N.	Curtis-Zoelly	..	2,507	1500	175.5	460	27.40	1.234	16.24	19,020	210.0	334.6	62.8	*Data from Manufacturer*
Bergmann	Curtis-Rateau	1909	1,562	1500	186.8	555	28.33	0.780	14.57	17,970	234.1	381.3	61.4	*Data from Manufacturer*
James Howden & Son	Zoelly	1909	6,383	1000	202.7	520	27.33	1.269	14.305	17,150	238.5	353.0	67.5	*Enginer, London*, 10/29/'09
M. A. N.	Zoelly	1910	1,400	3000	180.7	554	27.40	1.237	14.21	17,310	240.0	356.2	67.4	*Zeit. D.V.D. Ing.*, 12/10/'10
Escher, Wyss & Co.	Zoelly	1910	2,052	3000	193.9	585	28.39	0.750	13.04	16,290	261.5	392.6	66.6	*Zeit. F.D.G. Turb.*, 2/20/'11
Escher, Wyss & Co.	Zoelly	1910	4,189	1000	179.7	557	28.66	0.618	13.30	16,520	256.5	391.3	65.5	*Zeit. F.D.G. Turb.*, 2/20/'11
F. Ringhoffer	Zoelly	1908	3,000	1000	170.7	470	27.60	1.138	15.52	18,278	219.8	339.2	64.8	*Zeit. D.V.D. Ing.*, 12/10/'10
M. A. N.	Zoelly	1910	1,250	3000	182.1	582	28.82	0.540	13.09	16,500	260.2	404.5	64.4	*Zeit. D.V.D. Ing.*, 12/10/'10
Oerlikon	Rateau	1911	3,166	1500	213.9	663	29.25	0.367	11.44	14,970	298.2	450.6	66.1	*Engineering*, 10/20/'10
Escher, Wyss & Co.	Zoelly	..	5,118	1000	133.7	549	27.55	1.161	15.18	18,530	224.6	341.6	65.7	*Dinglers P.J.*, 7/15/'11
Escher, Wyss & Co.	Zoelly	1908	5,000	1000	166.4	539	26.38	1.736	16.13	19,350	211.2	330.4	63.9	*Zeit. D.V.D. Ing.*, 12/10/'10
Escher, Wyss & Co.	Zoelly	..	3,540	1500	155.1	469	28.21	0.838	15.07	17,940	226.3	349.5	64.8	*Dinglers P.J.*, 7/15/'11
Escher, Wyss & Co.	Zoelly	1910	1,641	3000	221.0	672	27.91	0.985	13.08	16,775	260.6	406.5	64.1	*Zeit. F.D.G. Turb.*, 2/20/'11
Escher, Wyss & Co.	Zoelly	1910	1,235	3000	176.8	451	28.39	0.750	15.35	18,156	222.3	357.8	62.2	*Zeit. F.D.G. Turb.*, 2/20/'11
British Thomson-Houston	Curtis	1911	2,987	1500	154.7	505	26.75	1.557	15.96	18,960	213.7	321.2	66.5	*Engineering*, 10/20/'11
Gen. Elec. Co.	Curtis	..	3,464	..	210.0	513	28.75	0.575	13.62	16,620	250.4	393.4	63.6	*Trans. A.S.M.E., vol.* 32
British Thomson-Houston	Curtis	1909	2,500	1500	126.5	414	28.47	0.711	15.92	18,590	214.0	336.1	63.7	*Zeit. D.V.D. Ing.*, 12/10/'10
A. E. G.	Curtis	1906	3,000	1500	191.3	590	29.05	0.427	12.79	16,240	266.6	420.4	63.4	*Zeit. D.V.D. Ing.*, 12/10/'10
A. E. G.	Curtis	1909	2,236	1500	191.6	654	29.34	0.284	11.77	15,450	289.8	455.8	63.6	*Zeit. D.V.D Ing.*, 12/10/'10
Gen. Elec. Co.	Curtis	..	8,880	..	192.5	487	28.02	0.933	15.05	17,965	226.7	359.5	63.1	*Trans. A.S.M.E., vol.* 32
British Thomson-Houston	Curtis	1911	1,541	1500	149.7	365	27.97	0.956	17.46	19,720	195.3	320.2	61.0	*Engineering*, 10/20/'11
Gen. Elec. Co.	Curtis	..	10,816	750	190.0	525	29.39	0.260	12.90	16,135	264.5	427.3	61.9	*Trans. A.S.M.E., vol.* 32
Gen. Eelc. Co.	Curtis	..	5,095	..	185.1	554	29.40	0.255	12.71	16,090	268.4	436.0	61.6	*Trans. A.S.M.E., vol.* 32
British Thomson-Houston	Curtis	1911	1,221	3000	134.7	448	27.16	1.353	17.75	20,690	192.2	314.0	61.2	*Engineering*, 10/20/'11
Gen. Elec. Co.	Curtis	1910	8,775	750	194.0	451	27.95	0.956	15.95	18,720	213.8	350.8	61.0	*Trans. A.S.M.E., vol.* 32

References: *Zeit. D.V.D. Ing.*—Zeitschrift des Vereines Deutscher Ingenieure; *Zeit. F.D.G. Turb.*—Zeitschrift fur das Gesamte Turbinenwesen; *Dinglers P.J.*—Dinglers Polytechnisches Journal; *Elec. Zeit.*—Electrotechnische Zeitschrift.

CO_2 Recorders

By A. Vincent Clarke

Some of the reasons given by engineers for not adopting the CO_2 recorder, or making a practice of analyzing the flue gases in their plants, have been pointed out in Power. The principal reasons appear to be that many engineers do not feel that they possess sufficient knowledge of chemistry to operate the apparatus, and, although a great deal has been written about the subject, the fundamental principles have not been given; consequently they have been unable to educate themselves.

Although the average engineer may be very proficient as a chemist, and hence it may be difficult to induce him to take an interest in subjects involving a knowledge of chemistry, if only he could be persuaded to take an interest he would find his profession much more interesting, and would benefit financially by his ability for cutting down working expenses.

Most engineers consider that they know what occurs in the boiler furnace during combustion, yet they do not seem to know what methods can be adopted to determine whether the maximum efficiency has been obtained. The latter knowledge should very simply follow on from the former and is in fact only the completing of the former knowledge.

It is well known that for combustion the burning coal on the grate should be supplied with oxygen, and that sufficient oxygen should be supplied so that all of the carbon in the coal can be converted into carbon dioxide (CO_2).

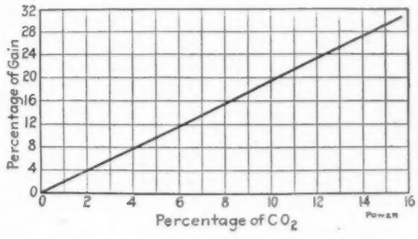
For the formation of carbon dioxide one atom of carbon unites with two atoms of oxygen or, by weight, 12 parts of carbon unite with 32 parts of oxygen, and during this formation much heat is generated. The oxygen is taken from the air which is allowed to enter through the ashpits.

If after its formation the carbon dioxide has to pass through the upper layers of the burning coal its tendency is to take up additional carbon and form carbon monoxide (CO). For the formation of carbon monoxide one atom of carbon unites with one atom of oxygen, or, by weight, 12 parts of carbon unite with 16 parts of oxygen; although it is composed of the same quantity of carbon but only half the quantity of oxygen as carbon dioxide, yet the volumes of the two gases are the same. By the conversion of one volume of carbon dioxide into two volumes of carbon monoxide heat is absorbed and the quantity of carbon taken up during this conversion is lost so far as this first process is concerned.

Carbon monoxide inflames at a comparatively low temperature, and in the furnace its combustion is secured either by the air passing in above the fire or by that which gets through the fuel bed uncombined.

Air contains four times as much nitrogen as oxygen; therefore in order to pass one volume of oxygen five volumes of air must be passed through the fire, or, by weight, 4 parts of oxygen to 18 parts of air. The nitrogen simply absorbs heat when passing through the fire and carries it to waste up the chimney, and this loss of heat cannot be remedied. If too much oxygen is allowed to pass through the fire, then this, with its accompanying nitrogen, carries so much more heat up the chimney.

Thus it is seen that if too little oxygen be supplied to the coal, then the combustion will not be complete and some proportion of the heat value of the coal will be lost, whereas if too much oxygen be supplied there will be a direct loss of heat up the chimney. Incidentally it is seen that a thin fire facilitates combustion by offering the least resistance to the passage of air through it, and so minimizing the risk of the formation of carbon monoxide; great care must be taken, however, that with this thin bed of fuel it does not burn into holes and allow air to pass through without having its oxygen consumed, thus causing a waste of heat.



Efficiency Increasing with CO_2

The composition of the flue gases varies considerably, and the efficiency of combustion can be determined only by an analysis of these gases. By this means it may be ascertained whether there has been a loss of heat by the admission of a greater amount of air to the furnace than is necessary for effecting proper combustion, or by the admission of a smaller amount of air than is necessary, thus allowing the escape of carbon monoxide.

In a complete flue-gas analysis the most important constituents of the gases to be determined are: carbon dioxide, carbon monoxide and oxygen, the remainder of the gases being nitrogen and a small proportion of other gases originating from the coal and the air. The presence of carbon dioxide shows complete combustion, that of carbon monoxide, incomplete combustion.

The accompanying figure shows the gain in efficiency that it is possible to obtain by increasing the percentage of carbon dioxide in the flue gases in a plant in which the percentage is as low as 5 per cent.; if this could be increased to 15 per cent., then an increase in fuel efficiency of nearly 20 per cent. would be accomplished, and it can be readily seen that this means a large saving of money.

CO_2 recorders are very essential for the attainment of the maximum efficiency of the process of combustion, but inasmuch as they give a continuous record of the percentage of carbon dioxide, they should be regarded as giving only a general indication of the efficiency for they do not give an idea of the possible losses due to incomplete combustion. Probably the best system of flue-gas analysis is one in which a continuous record of the carbon dioxide is obtained by means of a recorder and an occasional record of all of the other gases is obtained by means of the Orsat apparatus.

By means of a recorder, the stoker can detect any loss of efficiency in his furnace within two to three minutes of its occurrence; he has a guide as to the correct thickness of fire or the correct amount of draft to be given to the fire under varying conditions, and he has an indication should there be any leakage of air through the brickwork between the furnace and the position in the flue where the gas is taken from. These advantages can only be obtained by means of a recorder and its value is thus realized.

Devo Gasket

The Devo gasket is intended for high and low pressures, also for superheated steam, and consists of a corrugated steel gasket entirely embedded in an asbestos covering, which is graphited throughout. The gasket is $\frac{1}{8}$ in. in thickness, but it can be compressed to $\frac{1}{16}$ in.

Sections through Devo Gasket

Being deeply corrugated, this gasket will make a steam-tight joint even where the flange surface is unusually rough; it is applied inside the flange-bolt holes, thus requiring a small-size gasket. It is manufactured by the Goetze Gasket & Packing Co., New Brunswick, N. J.

Burst Flywheel at Gibsonburg, Ohio

On May 24, a flywheel in the Collier sawmill at Gibsonburg, Ohio, exploded. Part of the wheel crashed through the roof of the building, landing in the mill yard. One man was injured by the force of the explosion.

According to the press reports, the accident was due to excessive rim speed.

Electrical Department

Conducted to be of service to the men in charge of electrical equipment in the power house

Switchboard Connections for Testing Meters

By G. C. Cassard

In the electric-lighting business, satisfactory service depends largely upon the proper testing and maintenance of the various switchboard meters installed in the generating plant and substations. Much time is involved in this work at best, as certain types of meters require frequent attention, and it is quite important that the quickest and most convenient methods be employed consistent with safety. Of the various meters used on direct-current systems, ammeters are by far the most numerous, and for this reason the present discussion will be confined to them.

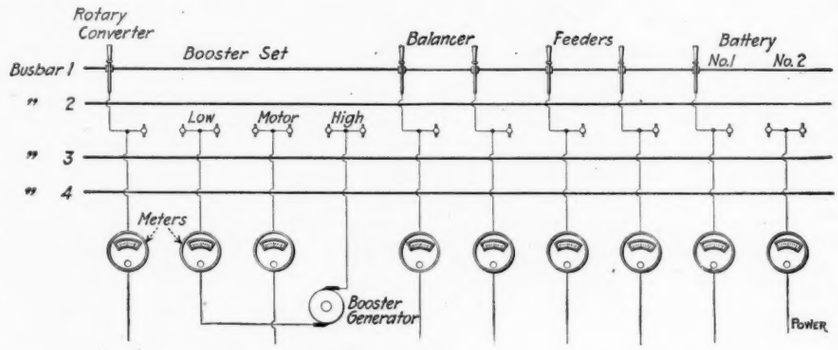


Fig. 1. Arrangement of Direct-Current Switchboard

In connection with the accompanying diagrams, the portable shunt and millivoltmeter method of testing is assumed as this is the most generally used. Fig. 1 shows a common arrangement of a direct-current switchboard (without auxiliary apparatus) when only busbar No. 1 is used during the periods of light load. This is the best time for meter testing, as it affords an opportunity to use any or all of the other three busbars for the various connections.

These diagrams may be taken to show either the positive or the negative side of the system, as both sides are handled similarly. In the arrangement under consideration there are two switches in each set, the left one engaging busbars Nos. 1 or 3, and the right one (shown open in a plane perpendicular to the page) engaging busbars Nos. 2 or 4. The switchboard meters are usually of the millivoltmeter and shunt type, like the standard, but are represented as in the diagram for the sake of simplicity.

Feeder Ammeters

Referring to the Fig. 2, it will be seen that, with the feeder under test on busbar No. 2, its load can be carried only in one way—that is, through the standard shunt, from busbar No. 1 to No. 2—therefore, this reading will appear on the standard meter and will be the lowest point of the check. The load may now be increased to any desired amount by connecting the jumper and carrying additional feeders on busbar No. 4 as indicated by the dotted line. The whole station load may thus be thrown on one meter if necessary, although that meter may be practically idle under operating conditions or be only a "spare," that is, entirely disconnected from the outside system. In making the changes shown, it is important to remember that the feeders in every case must be switched in on busbar No. 4 before pulling clear of No. 1; otherwise the feeder will be "dropped" from the switchboard.

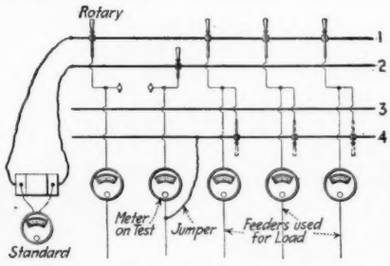


Fig. 2. Testing Feeder Meter

It is not practicable on a board of this kind to use busbar No. 3 as that would necessitate "flashing over" from No. 1 to No. 3, or tying in each time on No. 2 or No. 4.

Balancers

In the case of a balancer ammeter the connections are the same, but the scale reads in both directions from the middle, and after a check in one direction it is necessary to reverse the current. To do this, the left-hand switches are first all put back on busbar No. 1; then the right-hand switches are changed from Nos. 4 to 2, or 2 to 4, as the case maye be. This test must be made while the machine is running as the balancer switches are always at neutral potential when the machine is shut down.

Booster Sets

In testing the meter on a booster motor, the same wiring arrangement holds good. These motors, however, are usually connected directly across the system from the positive to the negative sidc, and the connections for testing must be made on the side containing the meter shunt. If connected otherwise, it is obvious that the artificial load would appear on the standard meter only, while the actual motor load would affect both meters. Here it is assumed that the motor is running during the test, and this is, in fact, the safest way. If, however, it should be necessary to test the meter while the motor is idle, and the test must be made on the positive side of the system, it is all-important that the field excitation switch be thrown to the "busbar" position before closing the positive machine switch. Disregard of this precaution will result in a heavy short-circuit. This applies only to switchboards of the type under consideration, but it should not be understood that this "shutdown" method is recommended in any case.

Where meters are installed on the generators of a booster set, as they sometimes are, such meters should be connected as shown in Fig. 3, and tested with the machine idle. It would appear, from the arrangement of the two sets of switches peculiar to a booster generator, that it would be simpler to switch the "high" side in on busbar No. 4, to replace the jumper. This is not advisable,

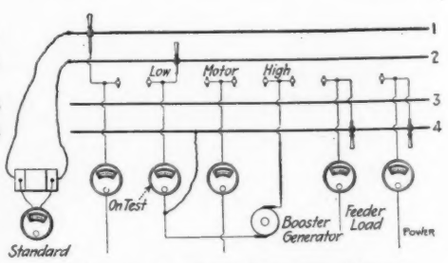


Fig. 3. Testing Booster Meter

however, as the testing current would have to pass through the armature and might be thoughtlessly increased to a large overload; also, if the machine could overcome its inertia and start up under these conditions, it would run away as a motor with no field. This, of course, could not occur if it had been previously started in the regular way and was controlled by its motor, but care should be exercised in that case not to excite the generator field and thus boost the feeders used for load. The use of the jumper is, on the whole, simpler and safer.

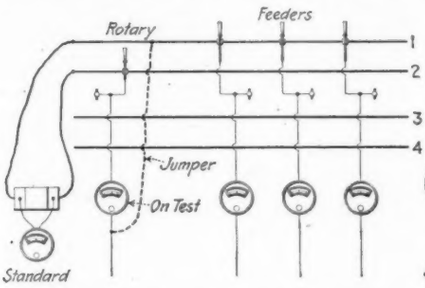


FIG. 4. CONNECTIONS FOR TESTING ROTARY CONVERTER METER

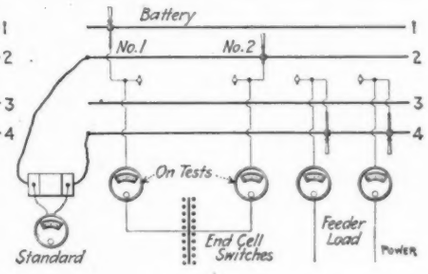


FIG. 5. TESTING BATTERY METERS

If the test must be made while the set is in service, connections similar to those shown in Fig. 3 may be used. Suppose, for instance, that the machine was boosting busbar No. 3, it will be obvious that the difference of potential between No. 1 and No. 3 will in no way interfere with the work if the connections are correctly made. The current measured under test in this case will evidently be that carried by busbar No. 3, plus whatever is thrown over to No. 4.

ROTARY CONVERTERS

In testing the ammeter of a rotary converter no feeder switching is required; it is only necessary to connect the standard meter as in Fig. 4, and throw the converter over to busbar No. 2. Then, having another converter running, the load may be shifted from one machine to the other; this shifting may even be carried so far that one machine will "invert" and run as a direct-current motor and build up an artificial load by feeding back into the alternating-current system. Therefore, the other converter will be carrying this heavy load and its meter may be checked at correspondingly high points. This does not mean that any extra demand is made on the alternating-current system as a whole, other than the power required to supply the losses in the inverted machine.

It must be remembered that a machine run in this way has its neutral position shifted several degrees back; that is, in a direction opposite to that of rotation, and the brush frame must be shifted to this point to prevent sparking.

In some cases, where the meter to be tested is on the only machine available, it is found necessary to connect a jumper across the meter and standard, thus shunting part of the load, as indicated by the dotted lines in Fig. 4. This makes it possible to obtain a lower scale deflection than that of the full load.

BATTERY AMMETERS

The battery in a substation is usually controlled by four sets of switches: positive No. 1 and positive No. 2, and negative No. 1 and negative No. 2. This does not necessarily mean that there are two batteries, but that the two extra sets of switches are provided simply for convenience in operating, and have their own end-cell switches at the battery and their own meters. This arrangement makes it possible to test the battery ammeters without charging or discharging, as will be seen by referring to Fig. 5.

By following the circuit from busbar No. 1, it will be evident that both of the meters will read, No. 1 indicating "charge," since the current is flowing toward the battery, and No. 2 indicating "discharge," as the current is returning through it. This current does not pass through the battery as the end-cell switches are both on the same cell contact, and are thus short-circuited on each other. It is important to see that this is the case before beginning the test, as otherwise the test current will pass through whatever cells happen to be included between the two switches.

With the busbar switches connected as shown, it is possible to calibrate meter No. 2 with precision, but the reading of No. 1 may be only approximately correct. This is due to the fact that there is usually a small "floating" current passing between the main busbar and the battery, and this current, although it affects meter No. 1, never reaches the standard meter. Meter No. 2, on the contrary, is in direct series with the standard meter and, if correct, should read the same.

The switches may be reversed without disturbing the feeder load if care is taken to switch in to the new position before pulling out of the old. The meters are now reversed, and No. 1 (which is now on busbar No. 2) will read "discharge" and be exact, while the other will read "charge" and be approximate.

The presence of this small disturbing current is, of course, unfortunate, but its value is nearly negligible, and if the reading is checked several times it introduces no practical error. Precise readings on the "charge" deflection can only be obtained by using less convenient connections or by charging the battery, which is not to be recommended.

Where a three-wire system is used, some companies install integrating ampere-hour meters on the neutral side of

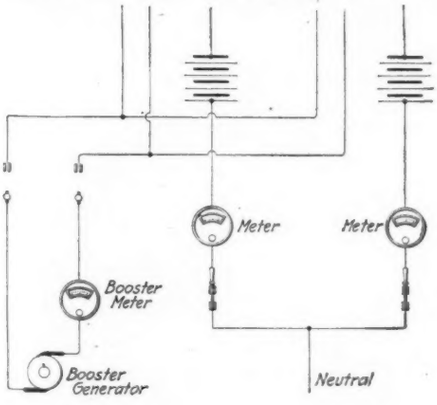


FIG. 6. METERS ON NEUTRAL SIDE OF BATTERIES

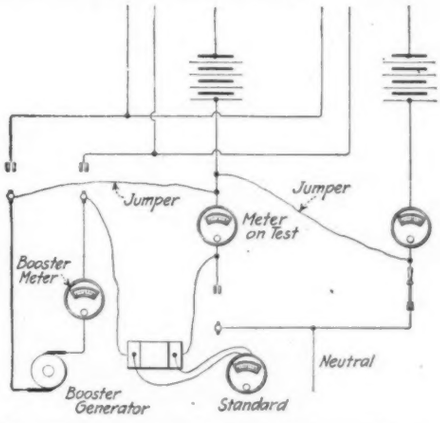


FIG. 7. AUXILIARY BOOSTER CIRCUIT USED FOR TESTING BATTERY METERS

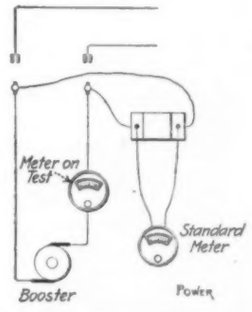


FIG. 8. TESTING AUXILIARY BOOSTER METER

the positive and negative batteries, at a position between the battery and the common connection to the neutral of the system (see Fig. 6). These meters are designed for both "charge" and "discharge," being provided each with two sets of integrating dials; they must therefore be calibrated under both of these conditions. Their position, however, is remote from the switchboard.

It sometimes happens that certain cells of a battery fall below normal voltage, while the rest hold up, and therefore means must be provided for charging these cells individually. This is usually done by running a separate set of two cables from one of the generators of a booster set into the battery room and continuing them above the battery as two bare copper bars. To these bars extension cables are connected and run down to the affected cells. This auxiliary booster circuit runs conveniently close to the meters, and has no arbitrary polarity like the buses. In fact, this booster circuit has been the only available source of current for testing these meters and gives a remarkably steady current at all loads.

The connections are shown in Fig. 7. As it is necessary under these conditions to open the neutral switch of the meter to be tested (the left one), the jumper shown on the right is used to maintain the neutral connection of the left-hand battery, and this must be done without including the meter, for obvious reasons. To reverse the current, the cables attached to the booster switches must be interchanged.

Individual Cell Charging Meters

The auxiliary booster circuit used in the foregoing test is equipped with an indicating ammeter as shown, and this ammeter might, of course, be checked for accuracy with the connections used in Fig. 7. When it is desired to test this meter only, the very simple arrangement shown in Fig. 8 will suffice.

In this as well as the last case, it should be noted that the booster generator is practically short-circuited and these tests should therefore be started on the weakest field possible; it may be built up afterward. A few points cut out of the rheostat will be sufficient under these conditions to bring the meter up to full-scale deflection or possibly overload the generator.

LETTERS

Too Much Compounding

A trouble with a small compound-wound, interpole generator which I was called upon to rectify may be of interest to other readers. The machine was a six-pole 40-kw. generator, running at 1200 r.p.m. It was designed to over-compound from 240 volts at no load to 250 volts at full load. The trouble experienced was that with the field rheostat set to give 240 volts at no load, when full load was thrown on the voltage would rise to about 290 volts instead of the 250 desired.

The first remedy tried, of course, was that of shunting the series field winding, but, while this helped somewhat, it was not nearly enough to correct the trouble. As an experiment, I cut out the series winding altogether, and was not surprised to see that with the shunt field alone, the voltage rose about 25 volts from no load to full load. This made it at once evident that the armature reaction must be boosting the shunt field; so I shifted the brushes forward several bars in order to make the armature reaction oppose the shunt field. On connecting the series winding in circuit again, there was no difficulty in obtaining the required degree of compounding.

I was, however, now confronted with a new trouble, that of bad commutation. As the natural shift of the brushes of a generator is forward, the only likely reason for bad commutation in the new position would be too strong an interpole field. Therefore, I weakened the latter by shunting it with a strip of german silver about 15 ft. long, having a section of 0.5x0.005 in. After that, no further trouble was experienced with either compounding or commutation.

L. S. Weil.

New York.

Chattering and Sparking Brushes

About 90 per cent. of commutator and brush troubles put down to faulty design are due entirely to lack of knowledge on the part of the men in charge of the plant. In order to keep a commutator in good repair, it is necessary that it should have the closest attention. Should the commutator commence sparking, it may be cleaned with a little kerosene, but too much should not be used as it is a very good insulator. Use sufficient to dampen a piece of clean rag and rub lightly across the commutator; if this will not remove the trouble, the brushes may be lifted, one at a time, and the bearing surface cleaned in the same manner as the commutator.

If the trouble is caused by a bad segment, it will be necessary to overhaul the machine. The commutator must receive the first treatment, after making sure that the trouble is not due to a short-circuited armature coil or a broken connection, which can be found by placing a galvanometer across the blackened segment. Now rub down the commutator with carborundum until the flat spot has disappeared, after which smooth off with sandpaper and polish. Next take out and thoroughly clean the brushes, and in resetting them place a strip of paper around the commutator; mark off where the ends meet, divide the paper into the same number of divisions as there are poles and again place this around the commutator. Now, if one of the brushes is placed to the mark on the commutator, it will be found to be slightly tipped and this must be fitted to the contour of the commutator. This is done by placing a strip of sandpaper between the brush and the commutator with the plain side against the commutator. It is then drawn backward and forward until the brush "toes the line" and makes a perfect contact with the commutator. After treating one brush on each pole in this manner the paper may be taken out and the other brushes treated similarly. Care must be taken not to place the brushes on the comumtator behind each other, but rather stagger them over the commutator so that the whole surface is covered.

When the brushes are finished they should be in perfect alignment axially. Before throwing the load on the machine the commutator must be wiped clean to make sure that no dirt has got under the brushes. Finally, the machine should be run without load with the brushes bearing on the commutator for some time. This will put a smooth surface on the brushes which will also help to polish the commutator.

Of course, faults may appear which are due to faulty design, such as weak insulation on the armature coils or soft mica between the segments, which burn away and cause the segments to be short-circuited, but, generally speaking, the trouble may be overcome by carrying out the foregoing instructions.

E. O'Shea.

London, England.

Thawing a Water Pipe

A 1¼-in. water pipe 900 ft. long froze on top of a hill and to thaw it out a 30-kw. 2300 to 122-volt transformer was used. The primaries were connected to the pole line through plug cutouts, and an ammeter was connected in the circuit. The 122-volt secondary terminals were connected directly to the pipe to be thawed out.

The circuit was connected to an idle alternator and the engine speed adjusted by throttling so as to make the transformer deliver about its full-load current. Regulating in this way from the station made it unnecessary to use any resistance in either the primary or the secondary circuit. The meters at the station showed 80 volts and 14 amperes [representing about 4¼ volts and 264 amperes in the secondary circuit—Ed.]. It took about four hours to thaw out the pipe.

Louis J. Gorilla.

Ironwood, Mich.

Gas Power Department

Worth-while gas-engine and producer information treated in a way that can be of practical use

Deterioration of Suction Gas Producers

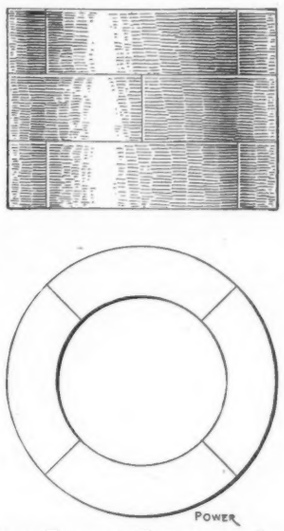
By J. A. Seager

It has been urged more than once against the use of suction-gas plants that, although for a time they appear to operate with considerable efficiency and satisfaction, they develop defects which after a few months' running cause very considerable trouble and in some cases lead to the redesigning or abandoning of the plant. It will generally be found, however, that such defects are traceable to causes which should have been foreseen, or if not should have been easily remedied at an early stage of the proceedings, and for this reason it may be claimed that the responsibility for many breakdowns of suction-gas plants rests quite as much with the purchaser and operator of the plant as with its designer and manufacturer.

Unfortunately for the prestige of this particular form of power source, it is largely adopted by people who are not technically expert and who may be located in out-of-the-way places where facilities for overhauling are somewhat limited even if the class of attention given to the plant is sufficient to detect faults in an early stage. Matters are therefore allowed to drift on until in the long run the trouble becomes so serious that it is almost impossible to remedy it.

The following incident will serve to show how very simply defects in suction-gas producers can be put right if they are taken in time. A suction producer and engine plant was installed under certain specifications as regards gas consumption. This engine, which was rated at 45 brake horsepower on suction gas, had a cylinder 13 in. in diameter and a 20-in. stroke and ran at 230 r.p.m. When it was first installed it averaged on a four-hour test run about 49 b.hp. and therefore showed a very good margin of power.

After it had been running for about nine months, however, some difficulty was experienced in carrying the load, and eventually it was found impossible to get the engine to take its full load. The matter was put in the hands of an expert, and on indicating the engine it was found that its indicated horsepower was between 48 and 49. Allowing the customary figure of 85 per cent. for the mechanical efficiency of the engine made the brake horsepower developed under the conditions of the second test about 41½. The engine was overhauled and carefully examined, but no defect was to be found in the engine itself. On inspecting the indicator cards, however, they showed "whale heads," indicating a weak mixture. This directed attention to the quality of the gas supplied to the engine and after a long search involving the overhauling of the generator it was found that the lining of the generator was leaky at certain parts of the joints; this allowed an excess of air to pass through, causing the weak mixture which reduced the horsepower of the engine.



A Good Form of Generator Lining

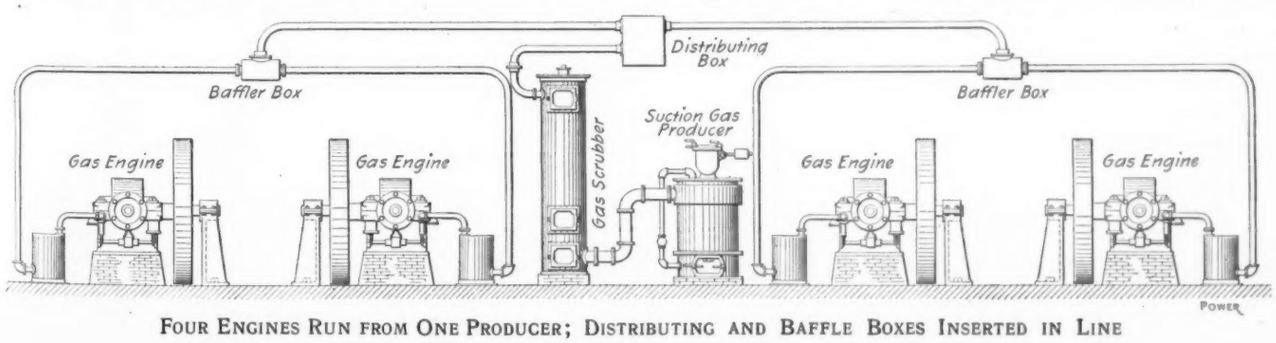
The indications seemed to show that the damage had probably been done by the too vigorous use of the poking bar when cleaning and stirring the fuel bed, and the very simple remedy was applied of putting gannister over the leaky places and black leading. This was a case, therefore, where, by reason of proper knowledge of what was required, the capability of the plant was restored with very little trouble. It may also be interesting to note that when suction-gas generators are being built it is always advisable to avoid joints in the lining as far as possible.

The accompanying sketch shows a very useful form of generator lining in which the material is built of quadrant blocks arranged in three tiers, the vertical joints being staggered. Where it is possible, in smaller sizes of generator, the number of joints can be still further reduced by utilizing blocks extending over 120 deg. each so that only three pieces are required in each tier. Generally speaking, the nearer the approach can be made to a monolith in the generator lining, the less likelihood there is of cracks developing which will allow undue admission of air.

Working Several Engines from One Producer

By W. E. Wort

A difficulty sometimes met with when attempting to run more than two units from one suction gas producer, is the tendency of one or more engines to get an irregular or insufficient supply of gas owing to a couple of the units synchronizing with their suctions, and so



Four Engines Run from One Producer; Distributing and Baffle Boxes Inserted in Line

causing a greater supply of gas to flow in their direction, owing to the stronger suction produced to the detriment of the supply to the other unit or units. This is very likely to occur where two units are run off one suction pipe at one end, and another unit is worked off the other end of the pipe.

The writer designed the arrangement shown in the sketch for working four 40-hp. gas engines from one producer, and in practice has found it very satisfactory. By the arrangement of baffles and expansion boxes it is as satisfactory when working one, two, three, or all four engines, although in this instance the gas producer was designed to supply two engines only.

It will be noticed that baffles or expansion boxes of large capacities have been fitted in the supply line by making the reservoirs nearest the engines about 2½ times the capacity of one of the engine cylinders; thus no interruption occurs in the supply to any of the engines.

A great benefit of the large reservoir near the producer (which should be about three and one-half to four times the capacity of all the engine cylinders) is that most of the dust and moisture are collected here, and, therefore, very little deposit is found in the other pipes or reservoirs, although the whole line of piping should be thoroughly cleaned out at least once a year. It is advisable to have drain cocks fitted to all the expansion boxes, so that the moisture can be drained periodically.

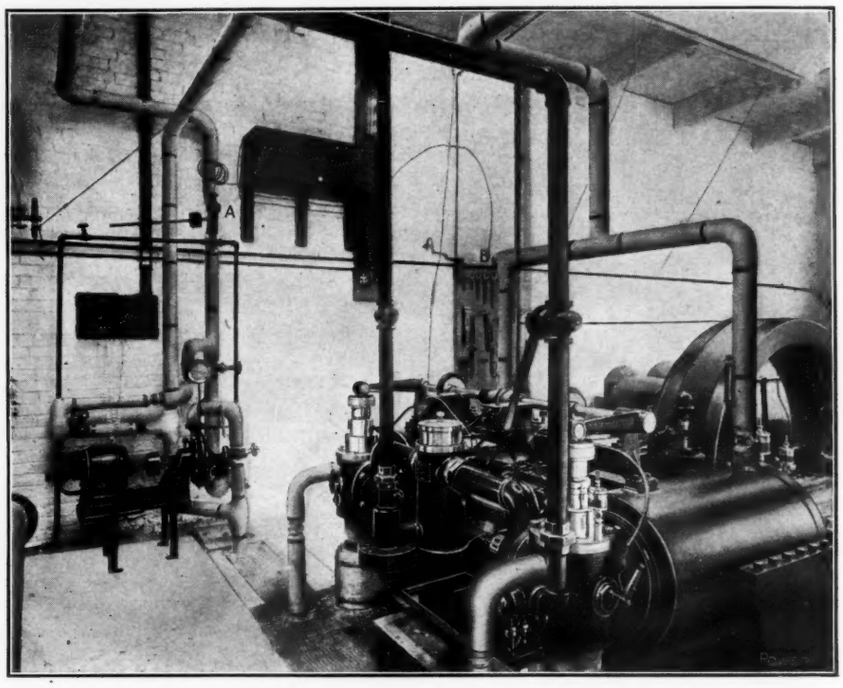
When working this installation the writer runs the producer on gas coke for the lighter loads, but for the heavier loads a proportion of anthracite coal is necessary, in the ratio of two of coal to one of gas coke. Of course, for the heaviest working, anthracite coal alone must be used.

Utilizing Waste Heat from a Gas Engine

An interesting method of factory heating is employed at the Hisey-Wolf Co.'s plant at Cincinnati.

The usual hot-blast practice is applied, using about 200 sq.ft. of heater surface, and in place of steam as the heating agent, the waste heat in the jacket water from a high-power gas engine is utilized. The water is circulated under pressure by an electrically driven rotary pump, through the engine jacket and a gas-exhaust water heater, then through a Vento fan coil and returns through the pump into the jacket.

Connected into the pump discharge is the city service line, which injects cold water into the jacket supply, under control of an Ideal siphon tank regulator, having its valve inverted to open with high temperature in place of closing. The thermostatic bulb of the regulator is placed in the flow pipe of the jacket water from the engines, and in this way the jacket water is held at the proper temperature. Referring to the illustration, *A* shows the main part of the regulator and *B* the stem (containing expansive fluid) inserted in the supply pipe and connected to the main part of the regulator by a flexible tube.



GAS ENGINE, PIPING AND REGULATING VALVE

As the jacket water must be held between 150 and 160 deg., a cast-iron boiler is cross-connected with the system to raise the temperature of the water in the fan coils in extremely cold weather, or when the engine is not running. The piping is so arranged that the flow from the boiler is directly into the fan coils and with the aid of the pump the proper amount is returned. It will also circulate by gravity independently of the pump and engine. Natural gas is used for fuel in the boiler, and the supply is automatically controlled. Also an automatic relief is provided to care for any surplus water in the system.

Explosion of a Diesel Engine

A short time ago a Diesel engine exploded at the United Machine Co.'s plant at Augsburg, Nuremberg, and resulted in several fatalities. From the report of the accident now made public it appears that the primary cause was the explosion of lubricating oil. There was an abundance of oil in the pump, and it had been carried into the receiver. A valve connecting the combustion chamber with the receiver was broken, and this brought about the ignition of the oil.

The explosion had a very slight effect on the machine, only parts of minor importance being destroyed. The greatest damage was wrought through the machine being surrounded by a scaffolding two or three stories high. The wood of this scaffolding during two or three months of experimenting had become saturated with oil and caught fire very easily. The receiver contained considerable oil which, after the explosion escaping in a burning state, set fire to everything around it not absolutely fireproof. The operators' clothes being greasy also caught fire. Had the explosion occurred to a machine fitted with iron gratings it would have passed without injury to anyone, and the damage probably would have been repaired in a few hours.

The loud report mentioned by the newspapers was not caused by the primary explosion but by a large vessel containing liquid oxygen which exploded through the heat. The whole affair was the outcome of several very unfortunate incidents which sometimes happen when new engines are tried.

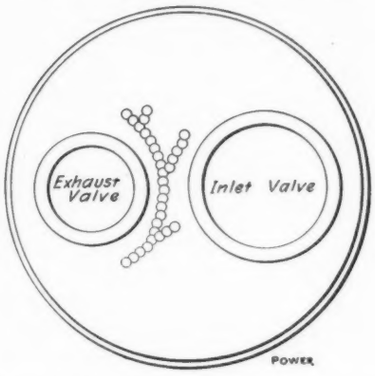
CORRESPONDENCE

Cylinder Head Repair

One of the cylinder heads on a 12x12-in. vertical gas engine developed a crack on the inside, between the inlet and the exhaust valve, both of which are in the cylinder head, and extended into the water space, letting the water into the cylinder and grounding the ignition points.

Something had to be done as the engine was needed badly, and as a new cylinder head would have cost $85, it

was decided to repair the cracked one. I accordingly drilled a 3/32-in. hole at the end of the crack, tapping it with a ¼-in. tap, then selected a piece of No. 2 copper wire, threaded it for a distance of ⅝ in. and screwed it into the tapped hole firmly. With a hacksaw I sawed it off, leaving the stud extending about ⅛ in., then drilled the next hole so that the drill just cut the edge of the first stud about 3/32 in. This second hole was tapped and the next stud screwed in. Care was taken to always get a good thread in the previous stud, making the



CRACK MENDED BY SCREWING IN COPPER WIRE

repair look as in the illustration. With a small riveting hammer I riveted the studs down, making it a solid patch the entire length of the crack.

The main crack was 6½ in. long and extended open about 1/16 in.; the smaller cracks were ½ in., 1½ in. and 1 in. respectively and thirty-one ¼-in. studs in all were required. The repair proved to be tight and cost only about a day's time with practically no expense for material.

M. W. UTZ.

Minster, Ohio.

Some Aspects of the Diesel Engine

The lecture delivered by Dr. Diesel before the American Society of Mechanical Engineers and which was abstracted quite fully in the May 28 issue of POWER, presented the results of experience running now over several years to show the economy of the principle, the lessened weight and bulk of the motor in marine service as compared with the combined steam engine and boiler and the gain in cargo space or in radius of action between fueling stations when oil is the fuel instead of coal. The case of fueling the vessel with oil as compared with the requirements with a collier supplying coal was notably made clear, and the convenient storage of oil fuel between the double bottoms of a steel boat and in spaces between bulkheads, where it not only steadies the vessel but is also in space otherwise unusable, was also a detail of interest.

The copious illustrations made it clear that the marine interests of Germany, Russia, France and Japan are far in advance of the United States in availing themselves of the economies and other advantages of the Diesel principle and in the use of oil for power; and the address concluded with a survey of some possible reasons why the Americans had allowed Europe to get in the lead.

The speaker specifically disavowed his responsibility as the originator of these explanations, but as coming from a friendly critic from outside, they were the more deserving of attention. Many engineers have acted in deference to their philosophy, perhaps without going to the extent of phrasing their explanations. Among them were the following:

The American has not yet felt the pinch of expensive coal to any extent. Fuel is costly in many places where transportation enters as a factor, but industrial America has developed near its fuel, and large plants have not been built on a large scale far to the north or to the south of the coal sources of the country. On the Pacific slope and in New England, the water power and the hydroelectric plants have been the satisfactory solution. The oil-fuel motor has grown only locally, on phosphate areas or in connection with remote mines.

The second and more important reason for the reluctance of the Americans was their attitude in favor of a low first or installation cost, even when the operating cost would be higher. The high compression pressure of the Diesel principle renders the best workmanship essential in construction. This quality of work is not cheaply obtained in America, or anywhere. Hence, the selling price of such an engine must compete at a disadvantage in the mind of a purchasing agent with the common or garden variety of motor, in addition to the obstacle of its being unfamiliar. Such a buyer must be shown and convinced that the difference in first cost of the familiar type and the new will be obliterated in time by the fuel-saving and that the interest on the difference in first cost will be more than paid in the yearly saving in fuel.

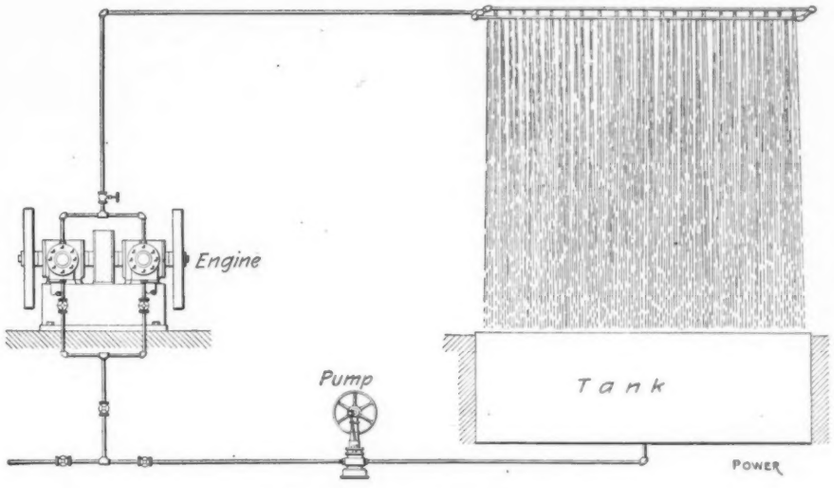
New York City.

F. R. HUTTON.

Cooling System for Jacket Water

Our plant is equipped with a 125-hp. gas engine and when I took charge, city water was used for cooling the cylinders. As from 7000 to 8000 gal. of water were used per 10-hr. day, I had a 6x6½x20-ft. concrete tank built in the ground and capable of holding over 5000 gal. of water. We filled this tank from the city supply and installed a 4x5-in. plunger pump to force the water direct into the water jackets of the gas engine. The return was led over the tank in two 1-in. pipes and sprayed through a row of ⅛-in. holes in each pipe to cool the water.

As these pipes are about 23 ft. above the tank, the water is kept cool enough to use over and over again, and by adding 500 gal. per day to make up for leakage and evaporation the tank is kept full all the time. The piping and valves are so aranged that the city supply can be used, should it be found necessary.



COOLING TANK AND ENGINE

This system has been in operation over a year and is very satisfactory; even in the hottest weather, we did not have any trouble in keeping the water cool enough. About 15 lb. pressure is carried on the line from the pump to the water jackets, and the tank is located about 30 ft. from the engine room. The arrangement has saved the company over $235 for the first year, and the installation complete cost only $150.

WILLIAM T. GARLITZ.

McKees Rocks, Penn.

Heating and Ventilation

Considered as power-plant problems. Layout and operation of systems and apparatus

Charging for Steam and Hot Water Service*

During the year the committee on steam heating of the National Electric Light Association sent out to a number of companies which are engaged more or less in the business of steam heating the following questions:

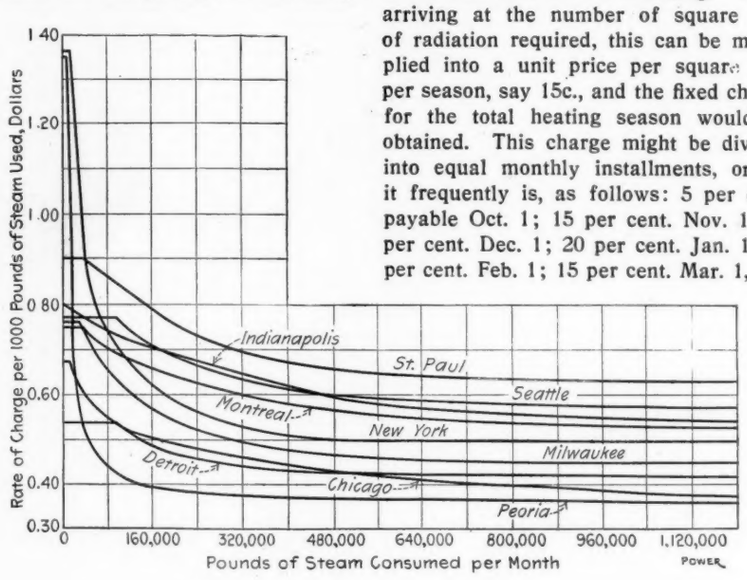
1. Do you heat by hot water or by steam?
2. If by steam, what is your net scale of prices per thousand pounds of steam?
3. Have you a net scale of prices per season for flat-rate service? If so, how are your prices determined?
4. What is the average cost of coal per ton of 2000 lb. in your town, also the average B.t.u. per pound of coal?
5. Do you consider the business profitable at these prices? If not profitable, do the resultant advantages in selling of electricity offset the losses on your steam business?
6. Do you have printed forms of contract for selling heat? If so, will you kindly furnish copies of same?
7. Do you furnish specifications to the consumer under which the equipment must be installed? If so, will you kindly furnish copy of same?

Nearly 100 replies were received and of this number about 75 were tabulated and presented in the report of the committee. Space is not available to publish the complete table, but reports from representative states have been included in the tabulation presented herewith.

In the replies to question 5 there was a fairly equal division of opinion as to whether the heating business is profitable or not. It was the general sense of the committee that a great many heating companies fail to properly figure their fixed charges on the cost of producing steam and that for this reason they have a fictitious profit. The steam company which is, perhaps, the oldest and does the largest business of any concern in the country, has adopted a somewhat higher schedule of rates than that of most of the heating companies. The fact that this company has done a large business on these rates would seem to support the contention that a great many companies sell steam at a lower price than they should. It would be well for each company, before determining its price, to make a careful estimate of its total cost, including the following items:

1. The cost of steam production in the plant.
2. The cost of steam distribution.
3. The cost of handling the business, including salesmen, collectors, etc.
4. General office expense.
5. The cost for insurance and taxes.
6. Depreciation and obsolescence.
7. Interest on the capital invested.

While the members of the committee recognize that at present the flat-rate method is the only practicable one for the hot-water system of heating, they agreed that the more satisfactory method of charging for steam-heating systems would be on the basis of meter readings. There was, however, some difference of opinion as to what extent the charge should be upon a meter basis. The simplest scheme is to make the charge depend absolutely on the amount of steam consumed, with a sliding scale for different amounts of steam consumed. In connection with the meter rate there should also be a minimum bill to secure the company against loss in installing and reading the meters.



METER RATES FOR VARIOUS CITIES

There are many, however, who believe that steam heat should be sold on a basis corresponding to that of many lighting companies which have a primary charge and a secondary charge, the primary charge being a certain sum per month depending upon the size of the installation served; and the secondary charge being based on the readings of the steam meters.

A large part of the cost of most steam-heating companies consists in their investment for boilers, buildings, steam-transmission systems and their accessories. It is very evident that a factory running 24 hr. a day would make a greater use of the same investment than a church, or a theater which is used only periodically. Accordingly, on the same consumption of steam, there might be a profit to the company in one case and a loss in the other, depending on the investment cost as compared with the steam sold.

For steam-heating service, the primary charge could be based on the theoretical steam-heating requirements of the buildings served. For example, the company should first by the regular formula determine the proper amount of radiation to be installed in the building. After arriving at the number of square feet of radiation required, this can be multiplied into a unit price per square foot per season, say 15c., and the fixed charge for the total heating season would be obtained. This charge might be divided into equal monthly installments, or, as it frequently is, as follows: 5 per cent. payable Oct. 1; 15 per cent. Nov. 1; 20 per cent. Dec. 1; 20 per cent. Jan. 1; 20 per cent. Feb. 1; 15 per cent. Mar. 1, and 5 per cent. Apr. 1. In addition there should be a meter charge at so much per thousand pounds of steam, rendered each month on the basis of meter readings.

In an interesting paper given by A. D. Spencer before the National District Heating Association in June, 1910, the author figured that the cost to the company in Detroit is practically 60c. per thousand pounds, including allowance for interest and depreciation. In the same paper he figured that the cost per square foot of radiation each year averages about 28.4c. He also showed in the same paper that the operating costs are just a little more than half the fixed charges. Therefore, the basis of the cost would be about 15c. per square foot of radiation per heating season, combined with a

*Excerpts from report of committee on steam heating read before the National Electric Light Association, Seattle, Wash.

meter rate of 30c. per thousand pounds as a secondary charge.

Byron T. Gifford, in his recent book on "Central Station Heating," figures that a central-station plant with an investment of $200,000 and a connected load of 200,000 sq.ft. of radiation, and with coal at $2 per ton, should have a service charge of 19c. per square foot of radiation, in addition to a meter rate of 30c. per thousand pounds of condensation. He figures on this basis an annual profit of 10 per cent.

The Wisconsin Railroad Commission, in its reports, Vol. II, page 302, states that with coal at $2 per ton exhaust steam can be safely sold at 50c. per thousand pounds. But it also states that if live steam is sold at this price there will be small profits unless large quantities of steam are sold. It would therefore seem, from the above data, that a fair average price for steam would be about 60c. per thousand pounds, or a combined rate of 15c. per square foot of radiation per heating season together with a meter rate of 30c. per thousand pounds for the secondary charge. This rate, however, is considerably higher than that secured by the average heating company.

The curves in the accompanying chart show the meter rates in different cities. These curves indicate that the average income received is considerably below the 60c. rate.

Enamel vs. Bronze for Radiating Surfaces*

Covering the surface of a radiator with paint or bronze affects the radiant heat only. The experiments made at the Royal Technical Institute, at Charlottenburg (Berlin), show that with low-pressure steam and a difference in temperature between the radiator and the surrounding air of 144 deg., a single-column radiator when painted with oil paint emitted 41.5 per cent. more heat than did the same radiator when galvanized with zinc inside and outside.

Peclet, the French physicist, who made exhaustive experiments on the radiating power of various bodies, calculated and tabulated corresponding coefficients, these being in each case the quantity of heat in B.t.u. emitted or absorbed per square foot per hour for a difference in temperature of 1 deg. F.

	Coefficient B.t.u.
Copper, silver-plated and polished	0.02657
Copper, polished	0.03270
Zinc and brass, polished	0.04906
Sheet iron	0.08585
Cast iron, new	0.6480
Cast iron, rusted	0.6868
Oil or varnish	1.4800

It may be noticed that the coefficient of radiant heat is about 50 times greater for oil or varnish than it is for copper, zinc or brass, the three metals which

*From "Ideal Heating Journal" of the American Radiator Co.

COST OF STEAM AND HOT WATER HEATING

Heat by	Price per 1000 Lb. of Steam by Meter	Price per Sq.Ft. of Radiation	Average Cost of Coal	Average B.t.u. per Lb. of Coal
Alabama				
Steam	85c. 1st 10,000 lb. 75c. next 10,000 65c. " 10,000 60c. " 20,000 55c. " 20,000 50c. " 30,000 45c. for excess Discounts: 10% 1st 100,000 lb. 15% next 150,000 20% " 250,000 25% " 250,000 30% for excess. Average rate 42c.	Minimum monthly bill	$1.50	13,500
Illinois				
Steam	70c. 1st 25,000 lb. 60c. next 25,000 50c. " 50,000 45c. " 50,000 40c. for excess Discount 5%	42c. 5% discount	$1.75	
Hot Water		16c.	0.90	11,000
Steam and Hot Water		30c., and 27c. over 2,000		11,000
Steam	60c.	35c.	0.90	12,000
Steam	75c. 1st 10,000 lb. 70c. next 10,000 65c. " 10,000 60c. " 20,000 55c. " 50,000 50c. " 200,000 45c. " 300,000 40c. for excess Discount 10%		2.75	10,000
Steam and Hot Water		35c., 25c. and 20c.	1.75	10,500
Steam		Flat rates	1.50	10,000
Steam	$1.50 1st 4,000 lb. 50c. for excess		1.10	
Steam	50c. 1st 5,000 lb. 45c. next 5,000 40c. for excess	Minimum monthly bill	1.10	
Hot Water		20c., 16⅔c., 15c., 12½c.		
Steam	75c. 1st 10,000 lb. 70c. next 10,000 65c. " 10,000 60c. " 20,000 55c. " 50,000 50c. " 200,000 45c. " 300,000 Discount 10%	30c.	1.675	
Steam	$1.50 1st 4,000 lb. 50c. next 10,000 45c. " 20,000 40c. for excess Discount 10%	D. R. 27.8 bus. 33.3 res. I. R. 33.3 bus. 38.9 res.	1.25	10,000
Steam	45c.		3.75	12,000
Steam and Hot Water	45c.	28c.	1.00	11,500
Hot Water		15c., 14c. over 1,000	4.00	
New York				
Steam	50c. Discount 10%		$2.48	14,000
Steam	50c.		2.18	14,000
Steam	48c.		2.40	
Steam	60c. 1st 50,000 lb. 55c. next 50,000 50c. for excess Discount 10%		2.80	14,000
Steam			2.65	
Steam		5c. per month	2.80	14,000
Steam	From $2.00 to 50c.		1.90 to 2.40	
Steam and Hot Water	60c. 1st 10,000 lb. 55c. next 10,000 50c. " 10,000 45c. " 20,000 42.5c. " 40,000 37.5c. " 250,000 35c. for excess Discount 5%		3.45	14,300
Steam	30c.—16.5 exhaust 50c.—24.0 live		2.20 2.30	13,500
Ohio				
Steam	36c. 1st 100,000 lb. 31.5c. next 150,000 27c. for excess Discounts 20% to 40% to current customers	35c. to 30c. 10%	$2.00	13,000
Steam	75c. 1st 10,000 lb. 70c. next 10,000 65c. " 10,000 60c. " 20,000 55c. " 50,000 50c. " 100,000 45c. " 200,000 40c. " 300,000 35c. " 300,000 30c. for excess Discount 10%	Minimum monthly bill		
Steam	35c. 1st 150,000 lb. 25c. next 1,350,000 20c. for excess	25c.		
Hot Water		17.5	2.26	14,000
Washington				
Steam	77c. 7,143–100,000 lb. 66c. 100,000–200,000 55c. for excess	Service charge	Use oil	
Wisconsin				
Steam	90c. 1st 10,000 lb. 80c. next 10,000 75c. " 10,000 70c. " 20,000 65c. " 50,000 60c. " 200,000 55c. " 300,000		$8.00 9.00	
Hot Water		25c.	2.85	14,000
Hot Water		22c. new, 20c. old business	2.60	13,000
Hot Water		18c.	4.85	
Steam	76.0c. 1st 25,000 lb. 66.5c. next 25,000 57.0c. " 25,000 47.5c. " 75,000 42.8c. for excess	Minimum monthly bill	3.00	13,500
Canada				
Steam	75c. 1st 25,000 lb. 70c. " 25,000 65c. " 50,000 60c. " 100,000 55c. " 100,000 50c. for excess		$3.50	12,000

fairly represent radiator bronzes. This indicates that metallic bronzes on the surface of radiation must have a tendency to check the flow of radiant heat.

The result of a large number of tests to ascertain the effect of bronze and radiator enamels on radiation is tabulated below:

INCREASED EFFICIENCY OF ENAMEL RADIATOR OVER SAME RADIATOR WHEN BRONZED

Kind of Radiator (All 38 in. high)	Per cent.
Rococo 1-column	9 0
Rococo 2-column	17.0
Rococo 3-column	16.5
Rococo 4-column	15.0

Hundreds of experiments and tests have shown that radiator enamels increase the heating effect of cast-iron radiation. The secret of the increase lies in the varnish, which constitutes the body of the paint or enamel. The better quality of varnishes, which are made from high-grade resinous gums, make the best possible base for radiator enamels.

Color has no effect whatever; it does not matter whether the radiator is covered with white, black, red, blue, green or yellow enamels, the effect on radiant heat is the same. Radiators have been covered with four coats of white enamel, one on top of the other, and up to the last coat the emission of heat gradually increased. Putting on five or six coats does not increase the emission, nor does it seem to diminish it.

Criticize This Heating System

Fig. 1 shows the steam pipes used for heating one part of our factory, the pipes being located along one of the walls. There are eight 1¼-in. pipes 150 ft. long in the building, only four of which are shown. Exhaust steam is used for heating.

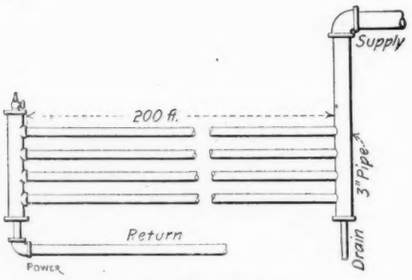


FIG. 1. PRESENT COIL

Last summer this building was lengthened about 50 ft.; the steam pipes were also continued from the old building up to the end of the new one, making the pipe 200 ft. long. As I expected to have trouble with these pipes due to their length, I recommended the installation shown in Fig. 2, but it was not adopted.

During the cold weather it was necessary to frequently repair many of the joints as they would leak considerably at the branching connections. This trouble was due to expansion and contraction, and at times some of the hook plates supporting the coils would be loosened from the wires. The building is heated only during the day.

After the heating season is over, the pipes will be changed to the arrangement shown in Fig. 2. Had this been done in

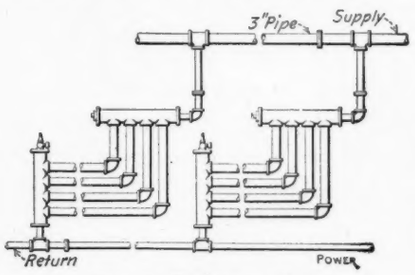


FIG. 2. PROPOSED COIL

the first place it would have been cheaper in the end.

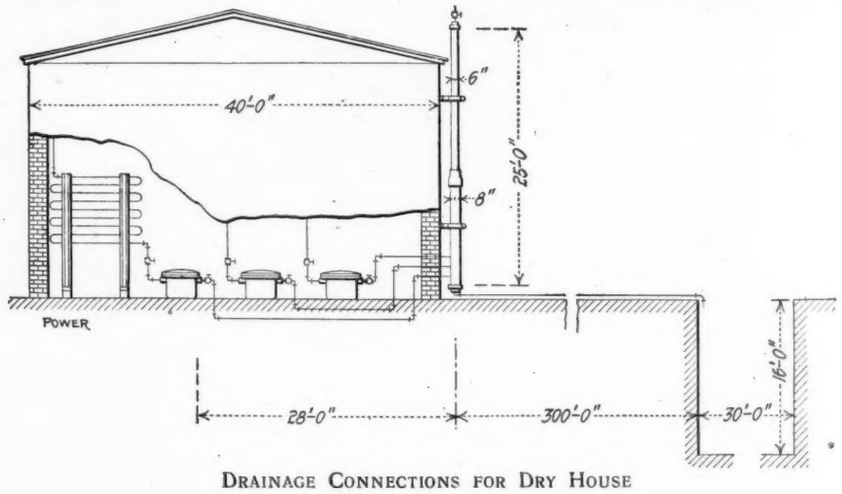
Can any reader of POWER suggest an improvement over the method shown in Fig. 2?

H. A. JAHNKE.

Milwaukee, Wis.

Draining Coils in a Dry House

The accompanying illustration shows the end view of a dry house that is equipped with 27,000 lineal feet of 1-in. pipe for radiating purposes. The drawing shows how the condensation from the coils is taken care of. This at times amounts to 10,000 gal. per 12 hr.



DRAINAGE CONNECTIONS FOR DRY HOUSE

The traps, which have 1¼-in. discharge openings, empty into a receiver at a height not to exceed 4 ft. above the trap.

The receiver is vertical and made up of 10 ft. of 8-in. pipe at the base and 15 ft. of 6-in. pipe for the upper portion, making a total height of 25 ft. The receiver is capped at both ends. The bottom cap is tapped for a 2½-in. pipe serving as an outlet from the receiver to a pool located 300 ft. from the receiver. The top cap is tapped for a ¾-in. valve connection.

The object in having the receiver so high is to aid in condensing the vapor that rises from the hot water as it is discharged from the traps.

J. W. DICKSON.

Memphis, Tenn.

Cause of Pump Racing

I have had charge of steam-heating systems with pumps piped similarly to that described by W. T. Moulton, and when they raced it was almost always due to vacuum in the system. With a heating system using three return-tubular boilers, each 66 in. x 18 ft., a ¾-in. vacuum breaker is not large enough to entirely prevent vacuum in the system, for it will take some time for the system to fill with air through that size of pipe.

With 4 lb. pressure and a dry return, the water will be very hot, and if the pump is only a foot or two below the tank, it might race with the drop in pressure from 4 lb. to atmosphere even without a vacuum. The racing is due to the temperature of the water in pump suction pipe being above the boiling point at the reduced pressure and the pump fills with vapor instead of water. If Mr. Moulton could get a vacuum gage he could tell how the pressure varied.

With a closed heater the make-up water can be put into the return tank cold, thus almost entirely removing the trouble. If the pump could be placed low enough, the racing could be stopped, but in many cases that is not possible. In case a pump is lowered, use a larger pipe for the vertical drop under the return tank, and steam forming in it will escape up into the tank.

By using a vacuum gage, lowering the pump or perhaps opening the back-pressure valve to be sure the 4-lb. drop is enough to make the pump race, Mr. Moulton can readily tell if it is advisable to make any changes.

HARRY D. EVERETT.

Ft. Apache, Ariz.

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POWER

Effect of Stiffness of Head on Braces

Away back in 1876, Samuel Nichols, a practical boiler maker in charge of a large English works, wrote a book for boiler makers. In it he recounts some experiments made under the supervision of Robert Nelson, author of "A Treatise on Steam Boilers," upon boilers built by himself for the purpose, with regard to unstayed heads in cylindrical shells. A boiler 30 inches in diameter with flat heads ⅜ of an inch thick, of plate having a "tenacity" of 21.2 tons per square inch with an elongation of 7.9 per cent., flanged on a radius of one inch inside the plate, was subjected to hydrostatic pressure. At 10 pounds the head had bulged $\frac{1}{16}$, at 120 pounds $\frac{1}{8}$ and at 150 pounds $\frac{13}{16}$ of an inch. Permanent set occurred somewhere between 50 and 65 pounds, at which latter figure the deflection was ⅜ of an inch. Rupture took place at about 300 pounds.

From the results of his tests, Mr. Nichols deduced a formula which is printed in his book for determining the bursting pressure of cylinders with unstayed heads, although he strongly disclaimed any advocacy of exposing an unstayed surface to high pressures. "On the contrary," he writes of himself, "he is more convinced, now that he has witnessed these experiments, that a flat unstayed surface is very weak indeed, and that they still require a larger amount of care and judgment on the part of boiler engineers than any portion of the boiler."

Evidently under the erroneous notion that if the head can take care of the amount of pressure indicated by this formula on its own account it will need corespondingly less bracing, the Board of Boiler Rules of Ohio, after instructing inspectors to determine the working pressure of boilers with respect to the bracing in the usual way but with an allowable stress of 8000 pounds per square inch irrespective of size, tells them, "To the above pressure may be added the Nichols formula with a factor of safety of not less than 8."

If this means, and it can seem to mean nothing else, that to the pressure which can safely be taken care of by the bracing may be added the pressure which, by the Nichols formula, would be allowed upon the unbraced head, it is wrong.

Mr. Nichols shows that the head may be bulged considerably without straining the sheet beyond the elastic limit. But a brace is supposed to be tight before the head commences to bulge. Just as soon as the head starts to move it commences to stretch the brace. Under the allowable stress of 8000 pounds per square inch of section a brace will extend only about $\frac{1}{3750}$ of its length, or a six-foot brace would extend less than 0.02 of an inch. The pressure which would produce the movement in the unbraced head is inconsiderable—a pressure of 10 pounds produced a movement of three times as much—and yet this is all the help that the stiffness of the head would be to the brace.

As an example, assume a 72-inch boiler, height of segment to be braced 24 inches, area of segment to be braced 814 square inches, pressure 100 pounds, thickness of head ½ inch, tensile strength 60,000 pounds.

The Nichols formula with a factor of safety of 8 would allow

$$\frac{t \times T \times 10}{A \times 8} = \frac{0.5 \times 60{,}000 \times 10}{814 \times 8} = 46 \text{ lb.}$$

If this may be added to the pressure which the bracing is capable of carrying, it would be necessary to brace against only 100 — 46 = 54 pounds per square inch, which at 8000 pounds per square inch would require seven 1-inch braces. Practice calls for at least twice as many.

Flue Gas Analysis

An engineer recently complained that POWER devoted too much attention to flue-gas analysis, concluding his objection by observing that not one engineer in a thousand could take a gas sample and analyze it.

These two statements are rather contradictory. POWER can hardly publish too much about CO_2 apparatus or the method

of determining the contents of flue gases, if engineers generally do not understand flue-gas analysis, and it is true that they do not.

Twenty-five years ago the indicator was a curiosity to most engineers. The man who owned one was called an indicator expert and was engaged to set engine valves for the man who did not own an instrument.

If engineering journals had remained silent regarding indicator practice, the indicator expert would still be in evidence, and the majority of engineers would still employ him to set the valves of their engines. Publicity educated engineers as to the value of the indicator, its use, and application. Today engineers who either do not own an instrument or know how to take indicator diagrams are in the minority.

In twenty-five years, probably less, flue-gas apparatus will be as well understood as is the indicator today, not so much because the device itself will attract attention as that articles, and more instead of less of them, will be published.

If improper combustion is taking place the engineer should be as keen in detecting that as he is in determining leakage past a steam piston. An indicator shows what is taking place in an engine cylinder. A CO_2 recorder shows what is taking place in the boiler furnace, and one is just as important to the engineer as the other.

No! POWER has not published too much about flue-gas analysis—rather too little if anything. More will come and the subject will be presented to our readers until it will be as common to find men analyzing furnace gases as it for them to take indicator diagrams.

After Honors, What?

No recent record of heroism has outshone that of the "humble toilers of the sea" at the time of the "Titanic" disaster. And looming large in the forefront were the engineer and boiler-room forces of the ill-fated ship.

A fair meed of recognition has been given them and now grateful survivors have honored the "Carpathia" crew by bestowing upon them medals in commemoration of their "coming out of the dawn" to save human life.

At the reception of the survivors' committee on board the "Carpathia," details of which are given on page 855, Capt. Rostron said: "I do not deserve this credit. It belongs to my crew for their loyalty, valor and fidelity to duty; they have brought this honor to me."

There they stood, engineers, firemen and coal passers, grimy and toil-stained as they came direct from their posts to join their officers in receiving tokens of bravery. "Thank you, sir," was all they said. What did they think?

They had been rewarded, but will their deeds soon be forgotten? Will the lesson taught by the "Titanic" horror awaken the authorities to their culpability and arouse them to take measures to prevent its repetition? Will heed be given to the Senate investigating committee's report?

Here are Chairman Smith's concluding words: "These men should be better paid for their labor and more highly honored in their calling. Their rights must be respected and their work carefully performed; harsh and severe restraining statutes must be repealed, and a new dignity given this important field of labor."

Not until these conditions are brought about will the men of the sea receive proper recognition for their devotion to duty and their vocation be held dignified and gravely responsible.

Calking Steam Boiler Joints

On page 846 a contributor, in calling attention to the ill effects of heavily hammering the calking tool when closing a leaky joint, states that many engineers make this mistake. Perhaps some of them do not do the work properly.

Superficially, the general opinion seems to be that calking a joint is simple, but if the work is not carefully done disaster may follow, especially if the boiler is under pressure while being calked. A sharp-pointed tool should never be used as a thin portion of metal is then driven between the plates and only increases the size of the fissure.

Grooves are also formed which enlarge rapidly under the combined action of corrosion, expansion and contraction. If extremely hard blows are given the tool and the joint is already badly corroded, serious results are inevitable. Such ignorant use of the tool will also stiffen lapped and single-strapped butt joints and create a local and intense expanding and contracting action which results in forming cracks under the lap. A round-nose or, better still, a fullering tool should be used, but not subjected to heavy blows.

A Contemptible Fraud

It was recently discovered that a fireman in a large plant nearly closed the steam blowers on his boilers to hold his fires longer, puting the necessity of more frequent firing on his mate.

How long this despicable thing might have continued before detection is a question. The offender could have long avoided being discovered, especially in a busy boiler room, by only partially closing each blower valve. This not only made his fellow workman do part of his work for him while he undeservedly received pay for it, but it forced the other man's boilers as well, and it was only when he overdid the thing that he was discovered.

It is mild indeed to say that such an act is on a par with stealing a man's lunch or opening his locker and taking his clothes or valuables.

Wilbur Wright

Motive power was necessary to the success of the aëroplane, and credit for its successful application to this form of conveyance belongs to the brothers Wilbur and Orville Wright.

The steam engine as applied by Prof. Langley to his "aërodrome," which unfortunately plunged into the Potomac, exerted an accelerating influence on the Wrights' achievements. From Langley's experiments, perhaps more than from any other source, was Wilbur Wright able to discern that power was indispensable to an aëroplane. Truly his success in applying it entitles him to the recognition given to other notable inventors. His loss to the science is great.

The recent meeting of the Mechanical Engineers at Cleveland brought out three papers big with interest for the power-plant engineer. Mr. Weymouth's paper on "Natural Gas" is a collection of data hitherto not widely available. Prof. Christie's paper upon "Large Steam Turbines" is an epitome of the present state of a rapidly growing art, but Prof. Clayton's "New Method of Analysis for Indicator Diagrams" is a discovery.

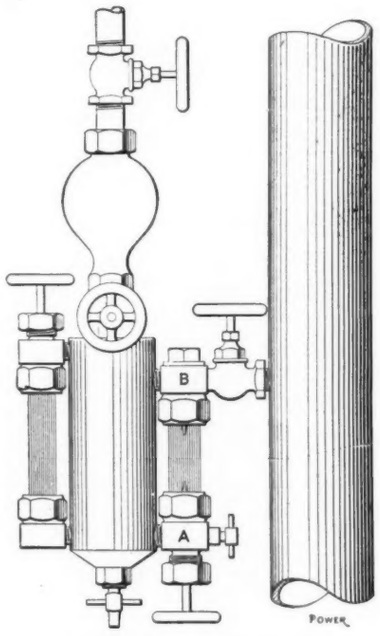
Readers with Something to Say

A letter good enough to print will be paid for. Ideas, not mere words, wanted

Lubricator Troubles

Formerly when I went into an engine room and saw the sight-feed glass of a lubricator blocked up, I thought the engineer a shiftless fellow. I would say: "He is just slovenly and careless; he can fix that lubricator so it will work well and look neat if he wants to." Sure, anybody can! What is a gravity lubricator, anyhow? Simplest piece of apparatus in the engine room.

My friends have often heard me express my opinion on this subject and for that reason when they come to visit me on the job, I quickly pass by the 18 and 10 by 12-in. duplex force pump,



LUBRICATOR CONNECTIONS

with the lubricator connected as shown in the sketch, because the sight-feed glass was blocked full of oil and I did not want to have them criticize me.

During the last six months I have cleaned that glass out twenty or more times a day, depending on how much time I had. I have cleaned the drop nozzle, filled the glass with ammonia and water, salt and water, kerosene and water; fastened a piece of metal from *A* to the steam pipe to keep the oil warm and thin, but all to no avail. The oil would drop clear a few times, then catch on the side of glass.

While working on it the other day I broke the glass, and when I put in a new one and attempted to tighten it I broke that also. Then I investigated (which I should have done before) and found that *A* had become turned so as to bring it out of line with *B*. The result was that the oil traveled from the nozzle in *A* up against the glass and discolored it. I turned it in place and now my troubles are ended. I have learned to be more lenient in my criticisms too.

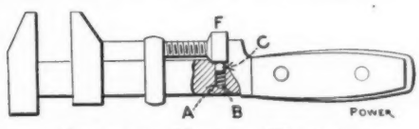
A. W. GRISWOLD.

Adams, Mass.

Improved Monkey Wrench

When a monkey wrench is no longer new it usually works so easily that it tends to shift its adjustment. I have overcome this trouble by removing the handle and screw and drilling a $\frac{1}{8}$-in. hole as at *A* in the illustration. Into the hole is inserted a spring *B*, the tension of which should not be too great. On the end of the spring the plug *C* is placed so that it binds against the knurled roller *F*.

This kink works most satisfactorily when using the wrench in cramped quarters. It may be further improved by drilling a number of depressions the size of the face of the plug into the roller. The spring would then force the plug into the depressions and hold it more firmly.



IMPROVED MONKEY WRENCH

JACOB LUSTENBERGER.

St. Joseph, Mo.

Restricted Flue Opening Causes Poor Draft

At one station in our system of water supply, there was trouble in keeping up steam to run the engines. As one part of the city depends upon this station for its water supply, it can be imagined what shutting down this station would mean. When the storage supply began to diminish, the officials became anxious and the chief of the department invited me over.

An examination of the fires proved that the trouble was not with the coal, as had been suggested, but with the draft. I could not find a damper in the flue to the stack; then I looked for some opening into the flue and found a small plate and raised it; the flue contained about 18 in. of soot.

I figured this much soot was not the whole cause for the poor draft as the flue was large. I then put a long dry stick down into the flue through the soot. When the stick was withdrawn the real cause for the poor draft was revealed, the stick being wet to a height of 2 ft., which added to the 18 in. of soot reduced the vertical diameter of the flue $3\frac{1}{2}$ ft.; this was too much for the work expected of it. When the water was pumped out things improved. There has been no further shortage of steam.

H. R. BLESSING.

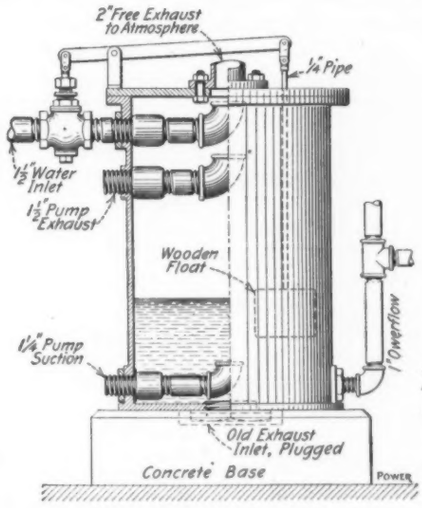
Philadelphia, Penn.

Serviceable Feed Water Heater

The accompanying illustration shows a home-made feed-water heater which I constructed from material gathered from the junk pile.

Having on hand the old shell of a closed heater, I decided to use it in making the open heater shown. The illustration shows the material used and the arrangement of the various parts.

A $4\frac{1}{2}$ and $2\frac{3}{4}$ by 4-in. duplex feed pump and a 6 and 4 by 6-in. service pump exhaust into the heater and produce a



HOME-MADE FEED WATER HEATER

feed-water temperature of nearly 212 deg. F. The surface water from the condenser enters the heater at about 100 deg. Approximately 2000 lb. of water per hour is heated. An oil trap is not needed with the heater.

The total cost of construction did not exceed $15.

W. H. BENNETT.

Seattle, Wash.

Repairing a Cracked Pump Cylinder

We repaired a cracked pump cylinder by drilling a hole at one end of the crack and tapping out for a ⅜-in. plug. We then drilled another close to the first one, letting the drill extend into the first plug about ⅛ in. The second hole was then tapped and plugged, and the method continued until the crack was covered. It was then smoothed off with a file and calked. Straps ⅜ in. thick used with iron cement further secured the job.

The pump has been running for some time with a 110-lb. pressure without signs of leaking.

F. H. COLEMAN.

Milledgeville, Ga.

Waterproof Cement for Belts

To put waterproof cement on belts requires more care, time and skill than to put on ordinary glue cement, but this is justified as the belt can be used then where a rubber belt would be ordinarily.

Unlike glue, the waterproof cement is used without heating and evaporates quickly; two coats of the cement are needed for a successful job. It gives the best results on good dry oak leather, but it must be dry and free from oil, as no cement will make a strong job on an oily surface.

The lapping ends must be cut straight and at the same angle to make the thickness of the joint uniform and equal to that of the body of the belt, as the joint must be effected by a steady pressure and not by hammering nor rubbing. The point of the lap uppermost should be about $\frac{1}{32}$ in. thick and a corresponding depression cut across on the heel to receive it. This allows the cement to impregnate the grain at the point and makes a stronger and better joint.

When the laps are made, scraping both surfaces of the lap raises the fibers of the leather and makes the cement more effective. As the cement evaporates rapidly when exposed to the air, only a little should be poured out at a time and preferably into a narrow, deep can. With a clean brush the surfaces should be given a good coat, working the cement well into the fibers. The second coat should not be applied until the first dries thoroughly, say from 30 min. to an hour; it will assume a grayish-white appearance when dry.

At this point a press clamp is needed which should be the same length as the clamps used to pull up the belt, but flat, about 4 in. wide on the face, and covered on both clamping surfaces with sheet rubber or felt. Bring the two lap surfaces together and tack one end when the laps lie straight, mark 4 in. from the other end and put the press clamp at the edge of the 4-in. mark; then raise the end of the lap and cement the 4-in. strip thinly and evenly and slide the press clamp over on the joint and tighten evenly and firmly. Let this set for 15 or 20 min., then loosen the other end, lift the lap and mark 4 in. ahead of the press clamp, loosen the clamp, then cement 4 in. and slide the clamp over and tighten it; cement just the width of the clamp each time until finished. The joint must set six hours before putting any strain on it.

When using waterproof cement keep it away from a flame or open light, as it is highly inflammable.

JOHN F. COCHRANE.

Norwich, Conn.

Calking Steam Boiler Joints

In calking steam-boiler joints many engineers make the mistake of heavily pounding the tool until further effort to stop the leak seems futile. With a high pressure in the boiler this method aggravates the leak as the internal pressure tends to open the fissure.

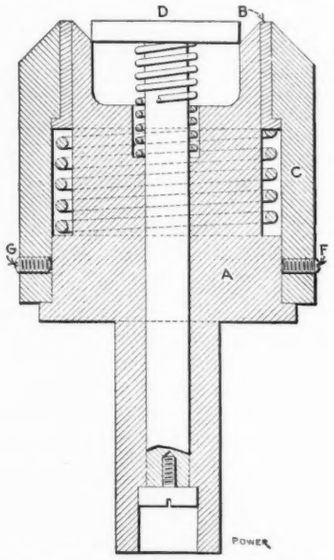
In calking, the point of the tool should be set a trifle above the joint and light blows applied to it. This will bring the plates together and materially lessen, if not entirely stop, the leak.

LLOYD V. BEETS.

Nashville, Tenn.

Punch for Making Washers

The illustration shows a tool for cutting washers from packing, which is cheap to make and very effective. Parts *A* and *C* are made of Ketos steel and shedders *B* and *D* are of machine steel. Parts *A* and *C* required no grinding after hardening as they did not change in size and assembled without any trouble. Part *C* is a driving fit on part *A* and is also held by two setscrews *F* and *G*. The washer is ejected by a shedder *B* and the scrap is forced from the center by shedder *D*. This tool is used in the punch press and strikes a machine-steel piece held in a bolster, thereby saving the cutting edges of the punch and completing a first-class job.



PUNCH FOR CUTTING WASHERS

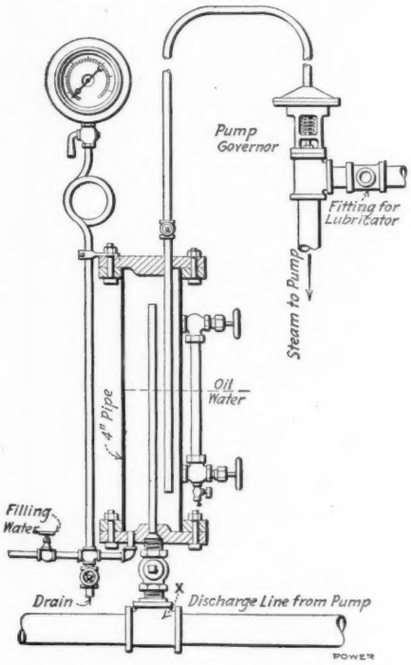
WALTER EDWARDS.

West Philadelphia, Penn.

[Ketos steel is a tool steel adapted to making dies, taps, etc., which may be hardened with very little distortion.—EDITOR.]

Separator for Oil Pump Governor

In the throttling control of pumps handling such fluids as fuel oil, which sometimes tends to become sluggish and clog, a separator device may readily be made by means of which clear water can be used as a pressure-transmitting medium between the valve-chamber bonnet, header or discharge piping and the pump governor. This not alone secures a more sensitive regulation, but by the introduction of pure water in the case of a governor containing a textile diaphragm the latter will last indefinitely, whereas fuel oil will soon cause it to deteriorate; the pressure gages in the above apparatus will also be kept clean and in better order.



SEPARATOR FOR PUMP GOVERNOR

The illustration shows a device which can be readily constructed. It is desirable to include a permanent water-supply connection from a source of moderate pressure as it will obviate the more tedious task of filling the chamber through a funnel. By selecting extra-heavy fittings and 1-in. nipples at *X*, no bracing is necessary if excessive vibration is not

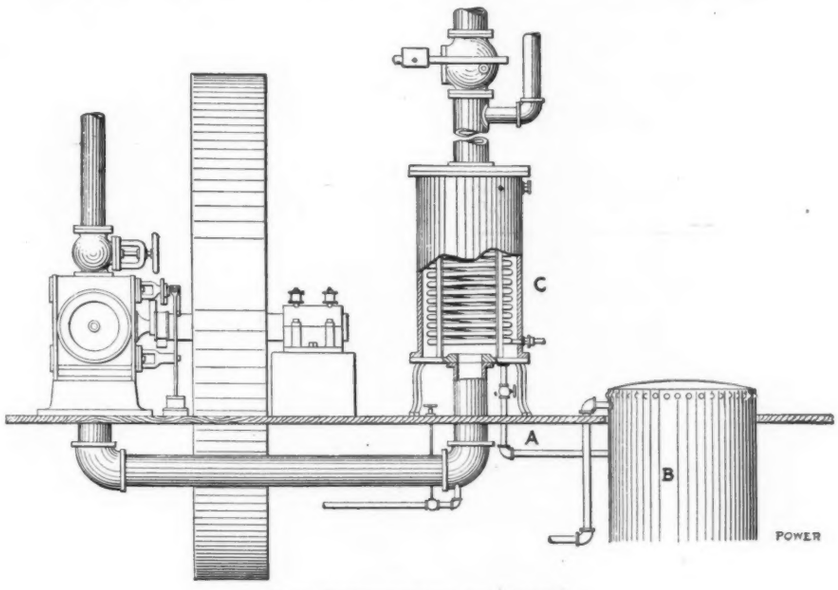
present in the discharge line. The apparatus is particularly desirable in the contol of heavy fuel fluids to steel furnace burners, and its application to other service is obvious.

B. G. STEWART.

Kansas City, Kan.

Heater Acted as Jet Condenser

The layout shown in the accompanying illustration caused me no end of trouble on several occasions. Without warning, this 16x48-in. Corliss noncondensing engine would act just as though someone had cut the main belt, suddenly relieving the engine of its load. The engine would practically double its speed for a period of about 12 sec., during which the slack side of the belt would flap violently and all the smaller belts would screech, due to the sudden increase in speed.



PIPE CONNECTIONS TO HEATER

The general conditions of the plant were such that it did not invoke surprise no matter what happened. The engine was said to be 52 years old, and everything else was in harmony with the engine.

After a thorough investigation I found that the drip *A* went into the blowoff tank, and when the water rose above the end of the drip, the velocity of the exhaust steam from the engine in close proximity to the heater drip *A*, caused the water in the tank *B* to be drawn up into the heater *C*, mixing with the exhaust steam and thereby creating a partial vacuum. As the drip *A* was only 1¼ in. in diameter it was not long enough to maintain a vacuum of about 8 in. for a longer period than 10 or 12 sec., thereby causing the heater to act as a jet condenser. After I changed the drip from the tank to where it could get no water over the end, there was no further trouble.

A. C. WALDRON.

Revere, Mass.

Welding a Cracked Furnace Door

I applied the autogenous process of welding to a crack in the firedoor which extended through the rivet hole from the edge of the plate to about 4 in. beyond the rivet hole.

The rivet in the hole through which the crack passed and one on each side of it were taken out and a wide V-groove cut along the crack, almost through the plate and about ½ in. beyond the end, leaving a thin sheet of metal $\frac{1}{16}$ in. thick to weld against.

The flame of the welding torch was then applied along the crack and mild steel melted in it until the crack was filled, every inch or so being hammered smooth with the sheet. The rivet hole was also filled and later drilled out for the rivet.

After the crack was filled and smoothed over, it was annealed, the rivets replaced, and the boiler put into service. The operation was entirely successful.

ROBERT VOSS.

Holyoke, Mass.

What Cuts the Top of the Cylinder?

A very elusive knock which appeared and disappeared without any apparent reason developed on the high pressure side of a 1000-hp. Corliss engine. When running with a full load the knock was slight or entirely absent, and at times it would be heard when the load was light; in starting and stopping it was severe. Our efforts to locate the cause were futile, and though we thought several times that the trouble had been located and cured, the knock came back. We took out the boxes and scraped and adjusted them carefully, tested for loose pins, loose crank, piston and follower plate, but everything was tight and the clearance was correct. Finally the builders' expert went over everything, took up a little more on the crosshead shoes, but he left the knock, and all the time it was growing worse.

About a week after, trouble was encountered in the metallic packing of the piston rod, to remedy which it was necessary to take out the piston and rod. When this was done, the interior of the cylinder showed the cause of the pound. Although the bottom of the cylinder was in fine condition, there was a shoulder worn at the top of the back end. A like shoulder also existed at the head end, but on account of its position it would not be noticed except by very close scrutiny. When the cylinder had been looked into, the bottom appeared so fine that there had been no thought of cutting.

At a line along the middle of the top of the cylinder the cut was about ⅛ in. deep and this shaded off to nothing on each side at about 50 deg. from the middle line. Next it was found that the rings had fared even worse, nearly ⅜ in. being worn from them practically all around. As each piston has only one sectional ring, it does not reach the counterbore; hence the shoulder.

As the ring was new, the builders were told that they had used a wrong kind of iron, but they denied this and came back with the claim that we used poor oil, but it was tested to specifications; moreover, on opening other engine cylinders no sign of such trouble was found. It certainly seemed to be due to the new ring.

The cylinder was rebored, a new piston was put in and for a time all went well until about four months later, when more trouble loomed up. Another engine is now ready for the boring bar and the rings are badly worn, two of the cylinders show considerable wear and the one where the trouble started has rejoined the list. The cylinders invariably cut on top, and in all cases the rings are badly worn. Superheated steam is not used.

We have found the cause of the pound, but what is the cause of the wear? The engine builders are now released. The boiler compound is under suspicion, but the makers positively assure us that there is nothing in it that could cause such trouble. Even if that is the source, why did the trouble appear in one cylinder so much earlier than in the others? Another engine taking steam through the same separator is even yet unaffected.

Why are not all the engines equally affected? Why do the cylinders cut on top? Why do the rings wear away so fast?

WILLIAM E. DIXON.

Malden, Mass.

Putting in a New Crankpin

It was decided to put a new crankpin on the low-pressure side of a 250-hp. Corliss engine. To get the old pin out, a number of holes were drilled in the ends of the pin near its circumference, and it was then driven out. A new pin was turned out and finished 0.004 in. too large and given a slight taper.

Three pieces of shafting were turned to fit the hole and heated in a portable forge. The crank disk was heated red hot on one side by inserting the hot pieces of shafting in the hole. When the disk was red hot, the new pin was driven in with a sledge-hammer using a brass bumper.

The engine was connected up and started without giving any trouble, and the new pin, put in about nine months ago, is still doing good work.

CLAIR A. GILSON.

East Lansing, Mich.

Timely Examination of Leaks

Some engineers and steam-fitters allow leaks on high-pressure steam and water lines to continue, not realizing how serious they may be.

One morning I noticed a small leak in one of the joints of a ½-in. nipple which connects a globe valve to the main steam line on top of the boilers; this pipe furnishes steam to the factory. That night, after the steam was shut off and the leaky joint examined, it was found that the nipple was rusted and nearly eaten through at the threads. This nipple was cut from a length of ½-in. standard pipe and was only in service about two years.

I believe the quick wasting away of the nipple was due to the fact that very little steam is taken from this pipe and it is frequently full of water. Had I not removed the nipple that night, I am quite sure there would have been a shutdown at the plant the next day, due to the nipple breaking at the joint.

Another case was that of a 1x3-in. nipple in the lower pipe connection of a water column which started to leak at one of the joints. At night, after quitting time, the pressure was removed from this boiler and when the defective joint was examined, it was found that the nipple was nearly eaten through at the threads. I could not understand how it had held the pressure.

After this experience I made it a practice to test all pipe connections in the water column when the boiler was being cleaned by tapping lightly with a hammer. If a pipe or nipple showed signs of being defective, it was immediately removed.

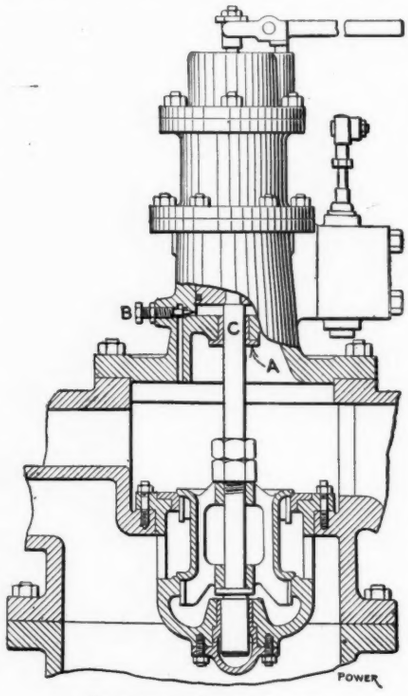
H. A. JAHNKE.

Milwaukee, Wis.

Turbine Repair

Our 500-kw. turbine would overspeed on light loads considerably. After trying several means of overcoming this trouble we finally decided it was due to steam leaking through the cylinder relay bushing *A* in the accompanying illustration, thus preventing the poppet valve from closing when the needle valve *B* was tightly closed.

Examination showed a clearance of 0.009 in. between the bushing and the spindle *C*. A new brass bushing was put in to replace the worn cast-iron one. The clearance then measured 0.002 in. This seemed to be insufficient as the valve was not sensitive enough in its action, even though much steam was admitted through the needle-valve.



TURBINE POPPET VALVE

The trouble was effectively overcome by stopping the turbine and injecting oil through the needle-valve passage with a squirt gun. The valve has worked well ever since.

F. MARTIN.

College Point, N. Y.

Cleanliness and Mechanical Efficiency

A large Western concern having 25 or 30 power plants recently issued a bulletin containing the following paragraph:

"A prize of ten dollars will be awarded to each plant employee having the best-looking apparatus, outside and in."

There is plenty of room for improvement in the appearance of nearly all power plants, and while I am strictly in favor of cleanliness, my argument is that a plant may be neglected in cleanliness and be superior in mechanical efficiency to one with everything shining and spotless.

For example, a boiler may shine with highly polished trimmings, valves, gages, etc., and at the same time be badly scaled, the valve stems need repacking, the tubes dirty and the water column nearly clogged up. An open feed-water heater may be spotless outside, and on the inside the baffle-plates may be so corroded that the perforations are filled, and possibly the coke or other filtering material has not been cleaned for months.

The bulletin is no doubt an inducement and a large factor in having employees keep the stations clean, but I believe that a plant should be judged by its mechanical efficiency first of all.

C. E. ALDRICH.

Mendota, Calif.

Reducing Labor and Filtering Oil

The engine in our plant is set upon a sub-base that rests upon a cement foundation. Inside the sub-base, just under the crank disk and connecting-rod, is an oil tray, which catches the oil drained from the crosshead, guides and crank disk. There is a ¼-in. pet-cock screwed into a hole in the sub-base just above the bottom of the tray; from this pet-cock the oil in the tray can be drawn off.

As the capacity of this tray was small and as much dirt collected and fell into it, I devised a plan to filter the oil and lessen the labor of frequently emptying the pan.

In a 6-ft. space under the floor I placed an old oil barrel, beside the engine foundation, directly under the pet-cock. Near the bottom of the barrel I bored a ½-in. hole and screwed in a valve of the same size. I next sawed out a piece of the head about 8 in. square and fitted it with hinges. Then I bored a hole through the floor over the barrel and connected the pet-cock with a ¼-in. brass pipe, running it down through the hole in the floor into the barrel.

Whatever oil, water and dirt collected in the sub-base tray would run down into the barrel. I had already filled the barrel with water up to the height of the highest valve. As the oil ran into the barrel the dirt it contained would sink to the bottom of the barrel, leaving the oil clean. The oil or water could be drawn off at any time.

WARD T. MOULTON.

Portland, Maine.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

Turbine or Engine?

The writer is particularly interested in your editorial of June 4, 1912, inasmuch as the Spiro turbine, of which he is the inventor, appears to be responsible to some extent for its conception.

Some objects which are complex in their nature may best be defined by describing what they are not. The absence of certain actions or functions is occasionally more restrictive than the presence of a large number of those more commonly shared.

If turbines were all alike in action, and possessed a common feature by which

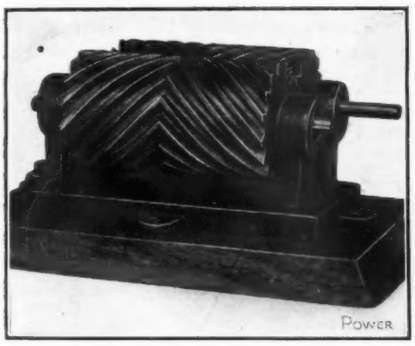


FIG. 1. A PAIR OF SPIRO ROTORS

they could be defined, it would be easy to dictate the limits outside of which a motor would cease to be a turbine. Evidently the editor selects "velocity action" as the defining element. The pile-driver lllustration is very apt in this connection, and certainly is analogous to the impact type of turbine where the initial velocities are high, ranging from 1000 to 4000 ft. per second, and the blade velocity only one-half the steam velocity. But how would this apply to the so called reaction type of turbine, such as the Parsons? Here the steam velocities are low, from 300 to 600 ft. per second usually, and the blade velocity practically equal to the steam velocity. How much effect would the blow of the pile driver have if the pile were moving as fast as the weight?

Evidently the "velocity" action will not do for the distinguishing feature.

Also, if it were possible to run a reciprocating piston engine at unlimited speed, the pressure action within the cylinder would decrease as the speed increased, and the velocity action would increase, so that in time the engine would be running under impact and the expansion would take place in the port which would correspond to a nozzle. But this increase in speed of action and consequent functional change could not be said to convert the piston engine into a turbine.

Just as it is practically impossible to give an intelligent definition of a human being, it seems impossible to rigidly define a turbine. Certain motors have, however, become definitely accepted by the engineering public as turbines, and others just as definitely established as engines. Let us analyze the established differences.

Turbines in general are distinguished by: high rotative and peripheral speeds; numerous blades, or vanes rotating about the axis; the absence of valves except as an adjunct of speed regulation, and extreme continuity of action due to the large number of blade efforts per revolution.

Engines, particularly rotary, are distinguished by: slower rotative and peripheral speeds; a few blades, or vanes rotating around the axis (rarely

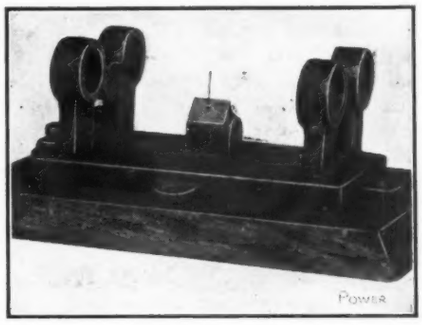


FIG. 2. THE INLET PORT OR NOZZLE

more than three in any rotary engine which has reached an operative state); the presence of valves, either reciprocating or rotary, and few steam efforts per revolution, corresponding to the number of blades.

There are exceptions to both classifications, and overlappings in some cases, but it is safe to state that if a motor partook of all the features described under "turbines" it would be proper to call it a turbine, whereas if it partook of all of the features stated above as peculiar to engines, it would be placed in the engine classification.

The impact turbine, as a class, has still another peculiarity which distinctly separates it from all other fluid motors—its ability to develop power and attain high rotative speed irrespective of its containing case. An impact turbine would operate as well without the case as with one, except that the steam, or other motive fluid, would escape into the room after leaving the wheel. This is not true of any other type of turbine, nor of a reciprocating piston, or rotary engine, so that if a motor possesses this peculiar feature, we may without argument place it in the impact-turbine class.

As to the Spiro turbine, there is no doubt in our minds as to its classification. Fig. 1 shows a pair of Spiro rotors mounted in bearings, and without an inclosing case or cylinder. Fig. 2 illustrates the inlet port or nozzle, there being two openings, one on each side of the central post, through which steam or air impinges upon the rotors. The opening on one side, indicated by the arrow, is so small as to be almost imperceptible in the engraving. This little model was made particularly to demonstrate the turbine action of the Spiro. As it stands, without a cylinder or case, and with 80 lb. initial air pressure, it develops a speed of 15,000 r.p.m. This is impact pure and simple, and places the Spiro without a cylinder in the impact-turbine class.

The addition of the cylinder adds another function—expansion—without detracting from the original impactive action. The range of speed in the commercial Spiro is from 1200 to 5000 r.p.m.; there are no valves, rotary or otherwise, except as adjuncts to speed regulation in the form of a governor throttle valve, and the steam action is perfectly continuous, due to the large number of blade efforts per revolution. In every respect it possesses the distinguishing features of a turbine as the term is known or understood, and the only argument that can be brought to bear against its being included in this classification, is that it utilizes the function of expansion within the tooth blades, notwithstanding the fact that expansion within the blades is a well known turbine attribute.

JOHN H. VAN DEVENTER.

Buffalo, N. Y.

Aid for Small Plants

More articles from men in charge of large power plants describing the operation in detail would help the engineer in the small plant to grasp their importance.

Necessity has compelled obtaining low cost for power production in the larger stations.

The smaller plants have not experienced the radical changes possible in the larger ones, and therefore show much less relatively marked improvement in their operation.

The reasons are clear, for with large interests in control they have been able to secure the best men in the field, who have, with capital behind them, been enabled to attack the cost of producing power from every angle, at an expense in many cases, even in proportion to its size and output, that would be prohibitive and disastrous to the small plant. Therefore, the men who can assist the smaller plants are most likely to be found in the larger ones, and they should be willing to give such information as would be practically applicable to the specific problems that confront the small plant.

The whole trend of things is to a greater economy and the conservation of the natural resources of our country. Let us have more letters from the big men.

R. A. MORSE.

St. Joseph, Mo.

A Troublesome Condenser

In reply to B. A. Jacobs' letter under the above heading, in the Apr. 30 issue, if the condenser loses its vacuum with no outlet to the atmosphere, the steam pressure will rise in the condenser and exhaust piping until the engine stops or something breaks, and the condenser shell, not being designed to withstand internal pressure, will probably burst.

Mr. Jacobs' information is insufficient to more than guess at the cause of the trouble. The steam used per horsepower-hour should be known, the size, type, speed, horsepower, point of cutoff and steam pressure, and the degree of vacuum desired; the type of condenser, whether jet or surface; the temperature of the injection water, the quantity of injection used, and the size, type and speed of the vacuum pump; if a dry-air pump is used, and the diameter of the injection pipe.

There are a number of interesting points in his layout. The pump condensers are on the engine-room floor; therefore condensation from the exhaust steam cannot properly drain into the condenser, but will accumulate in the exhaust line until the pipe is filled sufficiently to cause the back pressure to force it through.

The suction lift is excessively high. With 26 in. of vacuum it is not good practice to lift the injection water more than about 20 ft. by suction. This allows a good margin of pressure to accelerate the water and to overcome friction in the pipe.

There are two unnecessary fittings and four joints in the engine-exhaust piping which retard the flow of steam and increase the likelihood of leakage.

The injection line is so shaped as to form an air pocket just before the condenser is reached, the air going over into the condenser at intervals and causing a fluctuation of the vacuum.

By placing the condenser below the engine, the condensation would drain off and the suction lift would at the same time be brought down to where it should be. The engine exhaust line could have been dropped straight down to the level of the horizontal pipe, thus eliminating the superfluous elbows and joints and giving a more direct flow, yet passing below the belt shown.

G. H. BRIDGES.

Holyoke, Mass.

There is little chance of the engine running condensing very long. With the lift given, the pump has a fair piece of work to perform. Why not have the pump discharge the water through the condenser instead of having the condenser connected in the suction line? This water can be discharged from the condenser into a hotwell or taken care of by another pump.

I have operated expansion pumping engines without automatic relief valves, or valves of any kind. In Mr. Jacobs' case his heater and condenser would soon be subjected to dangerous pressure if the vacuum was lost.

J. P. COLTON.

Ohio City, Ohio.

If Mr. Jacobs would shut the valve between the exhaust line and the condenser, then try for a better vacuum, he might find a leaky suction pipe; if he obtains a better vacuum with this valve closed, it indicates leaks in the exhaust line. If the condenser loses its vacuum, the steam will blow back down the suction pipe and out through the suction and discharge valves of his condenser and through the discharge pipe.

Losing the vacuum will not harm the engine, but the condenser might be damaged. If the engineer was near-by, he could open the atmospheric valve and close the valve between the exhaust line and the condenser and prevent trouble.

SAMUEL H. WINTERBOTTOM.

Woonsocket, R. I.

Referring to Mr. Jacobs' inquiry under the above heading in the Apr. 30 issue, I would suggest that he search thoroughly for air leaks. If the condenser is of the surface type he may find the trouble in the air-pump valves. He complains of obtaining only 24-in. vacuum when the engine is idle. This, of course, depends upon the altitude, as 30 in. can be obtained only at sea level and the altitude of Frankfort, Mich., may account for the seemingly low vacuum. The best vacuum I have seen in naval service was 28½ in.

In testing for leaks use a candle in the usual way and stop the leaks with red- or white-lead putty mixed with litharge. Test for leaky tubes by filling the steam side with water under a pressure not to exceed 5 lb.

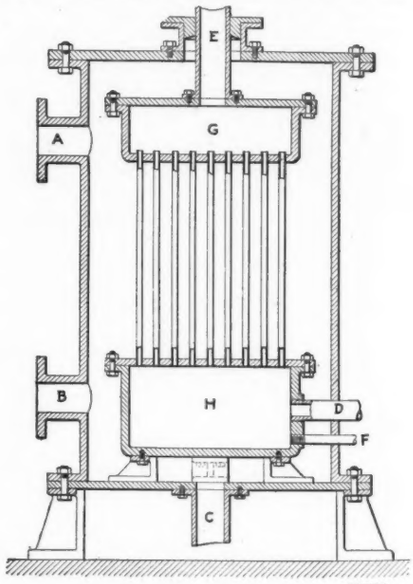
WILLIAM H. DALLEY.

San Francisco, Calif.

Feed Water Heater Troubles

Like Lindsay Duncan, whose letter under the above heading appears in the Apr. 16 issue, I have had considerable trouble with water heaters made somewhat after the designs shown in the illustration. Oil did not cause the trouble as in Mr. Duncan's case, but scale had completely filled the tubes connecting the chambers *G* and *H*. To clean them I had to remove the top flanges from the outer casing and drill the scale from the tubes after removing the cover from the compartment *G*.

After this process was gone through a couple of times I made a change in the heater, and instead of admitting live and exhaust steam through the inlets *A* and *B*, I connected the water inlet at *B* and



WATER HEATER

the outlet at *A*, with the live-steam inlet at *E* and the outlet at *D*. This change was made over a year ago and the heater still works very satisfactorily, although I was warned that this change would be a complete failure. Before it was made, the cold water entered at *D* and passed out at *E*. *F* is used for blowing out sediment. Pipes *F*, *D* and *E* are made of brass, the rest of the heater being cast iron. The large openings *A* and *B* are to be used for exhaust steam. For live steam these openings should be reduced to the desired size. Pipe *C* carries the water of condensation back to the hotwell.

JOHN THORN.

London Junction, Ont.

Inquiries of General Interest

All Questions Must be Accompanied by Name and Address—Not for Publication

Efficiency of Electric Plant

What are the brake horsepower, the mechanical efficiency, the electrical efficiency, the steam consumption per indicated horsepower, the steam consumption per brake horsepower and the thermal efficiency of a steam-electric plant indicating 240 horsepower and delivering 150 kilowatts to the switchboard? The steam pressure is 120 pounds gage. The temperature of the feed water is 207 degrees and the steam carries 2 per cent. of moisture.

F. J. F.

$$One\ kilowatt = \frac{1000}{746} = 1.34\ e.h.p.$$

$150\ kilowatts = 150 \times 1.34 = 201\ e.h.p.$

There are developed in the cylinder 240 horsepower to produce 201 horsepower upon the switchboard; the "overall" efficiency is therefore

$$\frac{E.h.p.}{I.h.p.} = \frac{201}{240} = 83.75\ per\ cent.$$

This includes the mechanical efficiency of the engine and the overall efficiency of the generator. If it is assumed that the mechanical efficiency of the engine is 93 per cent., the brake horsepower will be

$$I.h.p. \times mech.\ ef. = 240 \times 0.93 = 223.2\ h.p. \qquad (a)$$

The mechanical efficiency is the ratio of the brake to the indicated horsepower.

$$\frac{B.h.p.}{I.h.p.} = \frac{223.2}{240} = 93\ per\ cent. \qquad (b)$$

as assumed. The electrical efficiency will be the ratio of the electrical horsepower to the brake horsepower

$$\frac{E.h.p.}{B.h.p.} = \frac{201}{223.2} = 90\ per\ cent. \qquad (c)$$

The electrical horsepower is the product of the indicated horsepower and the overall efficiency. The brake horsepower is the product of the indicated horsepower and the mechanical efficiency. Substituting these values in the ratio just used, thus,

$$\frac{I.h.p. \times overall\ eff.}{I.h.p. \times mech.\ eff.} = \frac{overall\ eff.}{mech.\ eff.} = \frac{83.75}{93} = 90\ per\ cent.$$

shows that the same result may be attained by dividing the overall by the mechanical efficiency. The steam consumption can be determined only by test, and the thermal efficiency cannot be computed unless this is known. Assume that the engine takes 25 pounds of steam per horsepower-hour. The heat of evaporation of steam at 120 pounds (say 135 pounds absolute) is 869.9 B.t.u., but since the quality x of the steam is but 98 per cent., that is, only 0.98 of it is in the form of steam, it will take only

$$869.9 \times 0.98 = 852.5\ B.t.u.$$

to evaporate this much. The heat of the liquid at 135 pounds is 321.7. Each pound of working fluid will carry to the cylinder

$$852.5 + 321.7 = 1174.2\ B.t.u.$$

reckoning from water at 32 degrees as a base. But the exhaust is capable of heating the feed to 212 degrees, and the engine should be credited with the 180 B.t.u. in a pound of feed water of that temperature. The net heat supplied to the engine per pound of steam is therefore

$$1174.2 - 180 = 994.2\ B.t.u.$$

and the 25 pounds per hour will bring in

$$25 \times 994.2 = 24{,}855\ B.t.u.$$

A horsepower-hour is

$$33{,}000 \times 60 = 1{,}980{,}000\ foot\text{-}pounds$$

or

$$1{,}980{,}000 \div 778 = 2545\ B.t.u.\ per\ hour.$$

To produce the equivalent of 2545 B.t.u. of work, 24,855 B.t.u. have been used. The thermal efficiency therefore is

$$\frac{Heat\ value\ of\ h.p.}{Heat\ used\ by\ engine} = \frac{2545}{24{,}855} = 10.24\ per\ cent.$$

The feed-water temperature is given as 207 instead of 212. If this figure is used, it will give a somewhat smaller efficiency; but the engine gives back steam enough and hot enough to heat its feed to 212, and if the heater does not do it or the piping radiates it, the engine is not to blame.

Effect of Clearance

What effect has clearance on the mean effective pressure?

F. W. D.

Clearance has the effect of increasing the mean effective pressure both by increasing the mean forward pressure and decreasing the mean back pressure. The steam which expands after cutoff includes that which fills the clearance spaces; hence the greater the percentage of clearance the greater the average forward pressure. On the return stroke the volume of the space into which the steam is compressed determines the compression; therefore the average back pressure will be less the greater the percentage of clearance.

Heat of Steam

Some text books give the formula of evaporation as

$$Factor = \frac{H - h}{965.7}$$

In certain correspondence school books it is given as

$$\frac{H - t + 32}{966.1}$$

H = total heat in steam at pressure of actual evaporation

t = observed temperature of feed water.

Why this difference? How would results of an evaporative test of a boiler be affected by using the latter in place of the former?

Why are the pressures in steam tables quoted as 20.3, 21.3, 22.3, etc., in place of even pounds per square inch.

G. C. U. S.

Both formulas are based on the value of the old British thermal unit, viz.: the heat required to raise 1 lb. of water 1 deg. F. from 39.1 deg. F. The second one assumes that the heat in the feed water above 32 deg. temperature increases directly with its temperature, which is not strictly true. In this and other respects the first formula is supposed, when used with certain tables, to be an improvement on the second.

The difference between using one factor or the other would be scarcely discoverable in a practical evaporative test.

The most modern steam tables (Marks and Davis) are constructed on the basis of a heat unit being $^1/_{180}$ of the heat required to raise 1 lb. of water from 32 degrees F. to 212 degrees F., and employing their values of H and h makes the formula,

$$F = \frac{H - h}{970.4}$$

As the absolute pressure of the atmosphere is 14.7 lb. per square inch (at sea level) and the ordinary gage pressure has its zero at atmospheric pressure, then any gage pressure corresponding to an absolute pressure will be 14.7 lb. per square inch less than the absolute.

Thus the absolute pressure 35.0 will correspond to

$$35.0 - 14.7 = 20.3\ lb.$$

gage pressure.

During 1911, the exports of British coal amounted to $64,599,266 long tons.

Study Questions

This Week's Questions
Last Week's Answers

21. If the uphill speed of an automobile is 15 miles an hour, the downhill speed 30 miles an hour and the speed on the level 20 miles an hour, how long will it take to go 50 miles and return over the same course?

22. What will be the inside dimensions of a completely inclosed rectangular tank made of the least possible material to hold 500 lb. of water?

23. What will be the length of a vertical wire which will break by its own weight if the tensile strength of the metal is 40,000 lb. per square inch and the weight 555 lb. per cubic foot?

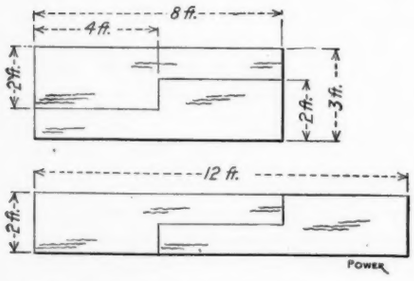
24. If a Fahrenheit thermometer indicates a rise of 45 deg., what will be the corresponding rise on a Centigrade thermometer?

25. If the displacement of a boiler feed pump is 1.25 gal. per revolution, then, allowing 20 per cent. slip, what boiler horsepower of 30 lb. water evaporated per hour will be supplied by the pump per revolution per minute?

Answers to the above will appear in the next issue. Answers to last week's questions follow:

16. Opening one link of each piece and welding to the next would require five cuts and five welds, but the job can be done with four cuts and four welds by cutting all of the links of one 4-link piece and using these links separately to join the other five pieces.

17.



The board can be cut as shown in the upper sketch and refitted as in the lower to cover the trench.

18. At the end of its stroke the energy in the hammer will be that due to gravity plus that due to the steam pressure. That due to the weight will be

$$W \times l$$

where

W = Weight in pounds;
l = Length of stroke in feet.

That due to the steam pressure will be

$$p \times a \times l$$

where

p = Mean effective pressure;
a = Area of cylinder in square inches.

Then

$$(W \times l) + (p \times a \times l) = \textit{total energy}$$

Substituting the known values,

$$(62 \times \tfrac{8}{12}) + (90 \times 3.1416 \times (3)^2 \times \tfrac{8}{12}) = 41.333 + 1696.464 = 1737.794 \textit{ ft.-lb.}$$

19. The energy in the hammer at the end of the stroke is

$$E = \tfrac{1}{2} Mv^2$$

where

M = Mass of the hammer $= \frac{G}{g}$, or the weight divided by the acceleration of gravity (32.2);
v = Velocity in feet per second.

Since

G = 62 lb. and, from problem No. 18
E = 1737.794 ft.-lb.;

Substituting,

$$1737.794 = \frac{1}{2} \times \frac{62}{32.2} \times v^2$$

$$v^2 = \frac{1737.794}{0.8074} = 2152.3334;$$

$$v = 46.39 \textit{ ft. per second.}$$

20. The article "Efficiency of Joints in Boiler Shells," printed May 14, page 703, explained fully why the stress on a longitudinal seam equals half the product of the area of the longitudinal central section by the intensity of pressure. In the present problem the area referred to is

$$66 \textit{ in.} \times 16 \textit{ ft.} = 66 \times 16 \times 12 = 12{,}672 \textit{ sq.in.}$$

the pressure 90 lb. per square inch and the force tending to rupture the shell along one longitudinal seam

$$\frac{12{,}672 \times 90}{2} = 570{,}240 \textit{ lb.}$$

Errata: In the answer given to question No. 5 in the May 21 issue, the term R = radius of the sphere, used in the formula should have been D = diameter of the sphere. In the numerical substitution the diameter 6 ft. was used, not the radius 3 ft., so that the answer a = 2 ft. was correct. There was also a typographical error in the last sentence where V should have been r as was indicated by the formulas following it. The latter were wrong from having used R = 6 ft. which should have been $\frac{D}{2}$ or 3 ft. when

$$r^2 = 2Ra - a^2 = 8$$

and

$$r = \sqrt{8} = 2.83 \textit{ ft.}$$
$$2r = 5.86 \textit{ ft.}$$

Mechanical Engineers' Spring Meeting

The spring meeting of the American Society of Mechanical Engineers was inaugurated at the Chamber of Commerce, Cleveland, by addresses of welcome by His Honor the Mayor and Ambrose Swasey, chairman of the local committee. The committee on constitution submitted proposed amendments to the fundamental law, simplifying the method of electing members, providing an additional grade of membership intermediate between the junior members and the members, those composing it to be known as associate members, while those "qualified to cooperate with engineers in the advancement of professional knowledge" will be known as heretofore simply as "associates." A further amendment makes the Committee on Constitution one of the standing committees of the society.

The secretary reported a substantial increase in the membership as the result of the recent election.

Following the business meeting the professional session opened with a paper by J. Paul Clayton on "A New Analysis of the Cylinder Performance of Reciprocating Engines." By plotting the ordinary indicator diagram on logarithmic paper the pv^n curve becomes a straight line. By noting the deviations from this the various events occurring in the cylinder can be analyzed, leakage detected and the clearance figured. It also furnishes a means for calculating the steam consumption.

The other papers of the morning were "Equipment of a Modern Flour Mill on a Gradual Reduction System," by John F. Harrison and W. W. Nichols; and "The Design and Mechanical Features of the California Gold Dredge," by Robert E. Cranston.

The Thursday morning session was taken up with the presentation of four papers. The first, by Thomas D. West, upon "New Processes for Chilling and Hardening Cast Iron," outlined a series of experiments to determine the effect of different methods of treatment in chilling and hardening cast iron during the process of cooling after pouring the mold. The first experiments showing how to produce mechanically mottled and white iron inside a gray body led to experiments with chillers and with various other heat-absorbing or hardening media, such as air, charcoal, powdered manganese, cyanide, etc.

The experiments indicated that the accepted idea of chilling entirely while the molten iron is solidifying, is wrong. They showed further that the stronger grades of iron can be used for car wheels, rolls, etc., and still obtain the desired depths of chill, also that air cooling is superior to metal chillers.

The next paper, by Reid T. Stewart,

dealt with the strength of steel tubes, pipes and cylinders under internal fluid pressure. It presented the results of a series of tests and investigations into the application of the five accepted formulas, namely, Barlow's, Lamé's, Clavarino's, Birnie's and the common formula $\left(ft = \frac{pD}{2t}\right)$. . These showed that Clavarino's formula is theoretically correct for cylinders with attached heads and Birnie's formula for heads held independently. These formulas are practically applicable to certain classes of seamless-steel tubing and to a critical examination of ordinary commercial steel tubing when accurate data are available.

In commercial welded pipe the variation in the thickness of the walls, perfection of the weld, etc., account for a variation in the bursting strength sufficient to render unnecessary any consideration of Clavarino's or Birnie's condition of head support. For ordinary commercial wrought-iron pipe Barlow's formula is recommended. This is

$$\frac{p}{f} = 2\frac{t}{D};\ p = 2f\frac{t}{D};\ t = \tfrac{1}{2}D\frac{p}{f};\ f = \tfrac{1}{2}D\frac{p}{t}$$

where

D = Outside diameter in inches;
t = Average wall thickness in inches;
p = Internal fluid pressure in pounds per square inch;
n = Factor of safety;
f = Fiber stress in pounds per square inch;
$= \frac{40{,}000}{n}$ for butt-welded steel pipe;
$= \frac{50{,}000}{n}$ for lap-welded steel pipe;
$= \frac{60{,}000}{n}$ for seamless steel tubes;
$= \frac{28{,}000}{n}$ for wrought-iron pipe.

Next came Prof. William F. Durand's paper on the "Control of Surges in Water Conduits." This dealt with the design of surge chambers having a tapering rather than a cylindrical form and embodied the development of a method by which the approximations of the various analytical and empirical formulas may be avoided and a chamber determined with a taper to suit the given conditions.

The final paper of the morning was by William Uhl upon the "Speed Regulation in Hydro-electric Plants." This, like Prof. Durand's paper, was of a highly technical nature and elicited practically no discussion.

The program for Friday morning included four papers: "The Present State of Development of Large Steam Turbines," by Prof. A. G. Christie; "A Discussion of Certain Thermal Properties of Steam," by G. A. Goodenough; "The Reduction in Temperature of Condensing Water Reservoirs Due to the Cooling Effect of Air and Evaporation," by W. B. Ruggles, and "The Results of Tests on the Discharge Capacity of Safety Valves," by E. F. Miller and A. B. Carhart.

The first dealt with the construction details of the leading types of large steam turbines, the commercial results obtained and the present tendencies in development. Owing to the importance of the subject, considerable discussion was evoked. An extract from this paper appears on page 831 and an abstract of the remainder of the paper will be printed in a latter issue.

In the absence of Mr. Ruggles, his paper was presented by F. E. Cardullo. This paper was based on the data obtained from tests on a cooling reservoir of about 6½ acres, the object being to determine from the heat radiation a reliable factor for use in determining the size of reservoir for any assumed conditions. The tests were made in May, July and November of last year and were each of a week's duration; the plant was of about 2500 hp. The average temperature of the reservoir was taken as the difference between the average inlet and outlet temperatures and the difference between this and the average air temperature as the temperature difference between the air and water. With these assumptions the heat absorbed by the air and by evaporation was found to be from 3.22 to 3.71 B.t.u. per square foot of surface per degree temperature difference.

In the discussion following, Mr. Cardullo criticized the method of arriving at the average temperature of the reservoir, claiming that the arithmetrical mean does not represent the average temperature, but rather, that it is more nearly the intake temperature, as the greatest evaporation occurs at that point. He also believed that Mr. Ruggles had erred in neglecting to consider wind conditions. From his experience, 3½ to 4 B.t.u. per square foot of surface per hour per degree difference of temperature was a factor close enough for all ordinary purposes.

The last paper of the morning, "The Results of Tests on the Discharge Capacity of Safety Valves," has already been printed in abstract (see POWER, Mar. 5, 1912, page 323).

GAS POWER SECTION

In the absence of the permanent chairman, F. R. Low presided, and in opening the session referred to the loss sustained by the gas-power section through the death of one of its most active members, F. H. Stillman.

The first paper, by Thomas R. Weymouth, dealt with problems in natural-gas engineering. It included a discussion of the properties of natural gas, supplemented by a table of analyses of gases produced in the principal gas fields of the United States. For use where analyses or a calorimetric determination of the heat value are not available, a formula was submitted for arriving at the heat value of a gas from its specific gravity, with very close approximation. The second part of the paper was devoted to the development of original formulas for the flow of gas in pipe lines, the power required for compression and the storage capacity of lines. This was further supplemented by examples showing the general method of designing a transmission system.

Prof. G. W. Munro's paper, "Some Tests of Carburetors," outlined the problem of carburation for motor vehicles and pointed out the difficulties met in determining the performance of a carburetor as distinct from the performance of the engine. The paper contained the results of some 400 economy tests on a single engine served by six different carburetors under identical conditions of speed and load. These tests lead to the following conclusions:

1. Under identical conditions of speed and load an engine gives materially different fuel economy when served by different carburetors.
2. Carburetor action is the limiting factor in engine capacity as well as in economy.
3. Each carburetor has distinctive performance characteristics which may be determined and plotted.
4. Wide range and perfect operation give no indication of fuel economy.
5. A carburetor giving excellent results under some conditions may give very poor economy over a large part of its range.

In the discussion, it was generally conceded that, although the tests were too limited to afford a definite basis for conclusions, Professor Munro had taken the lead in a field of investigation which might be followed up with very productive results. While the engineering staffs of many automobile manufacturers have given much time and attention to this problem and haye obtained very good results, generally each has been concerned with a particular make of engine, therefore the problem has not been treated as broadly as it might otherwise have been.

The point was also brought up that atmospheric conditions factor largely in the adjustment and operation of a carburetor.

George A. Orrok remarked that Professor Munro had failed to take advantage of some of the more improved types of carburetors and believed that more conclusive results might have been obtained with those having an auxiliary air valve.

Fred S. King, of the National Meter Co., said that his experience with the larger gas engines had been that the size of cylinders had a great influence upon the mixture.

The last paper at this session, by C. M. Garland, concerned bituminous-coal gas producers. It described the general arrangement of bituminous producers as designed for power, gave details of the scrubbing apparatus, data as to its efficiency and the amount of solid matter delivered. Figures for the first and operating costs at full load for a 1200-hp. plant were given so as to make them applicable to different conditions of fuel and load.

A fuller abstract of this paper will be given in a later issue.

Social Program

Much credit is due the local committee for the very complete arrangements covering the entertainment of members and guests. Beginning with a reception by Past President and Mrs. Swasey on Tuesday afternoon, a reunion of members followed in the evening at the Chamber of Commerce Hall.

While the professional session was in progress Wednesday morning, the ladies were taken on an excursion to the plant of H. Black & Co., cloak manufacturers. Luncheon was served by the society and in the afternoon parties visited the plants of the American Steel & Wire Co., the Brown Hoisting Machinery Co., the National Acme Manufacturing Co., the Peerless Motor Car Co., the Pennsylvania R.R. Co.'s ore-handling plant, the Warner & Swasey Co., the Winton Motor Car Co. and the White Co. In addition to these numerous other plants within the city extended the courtesy of inspection to the visitors.

After the trips, tea was served at the Country Club. In the evening a very interesting lecture on sound was given by Dr. Dayton C. Miller, of the Case School of Applied Science.

Thursday afternoon a boat ride was enjoyed on Lake Erie and in the evening a dance and reception was given at the Colonial Club.

Excursions to the plants of the Goodrich Rubber Co. and the Wellman-Seaver-Morgan Co., at Akron, on Friday afternoon, concluded the social program.

New Jersey N. A. S. E. Convention

The New Jersey State Association of the National Association of Steam Engineers held its annual convention at Krueger Auditorium, Newark, N. J., from May 30 to June 2.

The exhibition was opened on May 30 and was well attended. The convention opened at 2 p.m., Saturday, June 1, followed by a banquet in the evening.

J. H. Donnelly, President of the Common Council of Newark, delivered the welcoming address as Mayor Jacob Hausling was unavoidably detained. Edward H. Kearney, National President, told of the progress of the association, saying, in part, that the first national convention was held 29 years ago in a small room in Past President Beckerleg's house. The present convention was great in contrast as the city's largest hall was crowded. Judge Robert Cary, of the Supreme Court of Hudson County, gave a most interesting talk on the importance of the engineer in civic life and requested them to take a more active part in engineering political affairs to a better condition.

Past National President William Reynolds spoke of the value of coöperation, and Fred R. Low, editor of POWER, talked on the educational opportunities open to engineers which, if taken advantage of, would lead to still higher standing of the vocation. George W. Knight, chief engineer of public schools, read a paper on efficiency and its relation to the operating engineer. Mr. Knight's purpose was to stimulate action to betterment in operating practice. Alderman M. J. McGovern, Jr., also spoke on the value of intelligent coöperation. Curtiss R. Burnett, president of the Board of Trade, spoke of Newark's industrial growth. He quoted from statistics which showed that 252 different commodities were made in Newark and that last year's output amounted to $219,000,000. Good singers and humorists furnished enjoyable entertainment.

The Exhibit

The exhibit was unquestionably the most successful ever held in New Jersey. There were many booths containing power-plant requirements of all conceivable kinds. The firms represented were as follows: Albany Grease Co., Ashton Valve Co., American Engine Co., A. B. Botfield Co., American Oil & Supply Co., A. C. Lippincott S. S. & Supply Co., Boig & Hill, Buhne Metal Packing Co., Crandall Packing Co., Cooney & O'Rouke, Clement Restein Co., Crane & Milligan, C. T. Coe & Co., Crane Co., Couse & Bolton, C. E. Squires Co., Consolidated Packing Co., Cling Surface Co., Dayton Belting Co., Dearborn Drug & Chemical Works, David C. Seymour Co., Dixon Cascade Pump Co., Eureka Packing Co., Foster Engineering Co., Fletcher, Stanley Co., F. W. Webb Manufacturing Co., Griscom, Spencer Co., Greene, Tweed & Co., Garlock Packing Co., General Electric Co., Greenpoint Fire Brick Co., Home Rubber Co., H. W. Johns-Manville Co., H. B. Underwood & Co., Homestead Valve Manufacturing Co., Hewes & Phillips Iron Works, Heine Safety Boiler Co., International Acheson Graphite Co., Iron Works Co., International Correspondence Schools, Jenkins Brothers, Jackson Awning Co., James W. Crane, John A. Roebling Sons' Co., Keystone Lubricating Co., Lunkenheimer Co., L. J.

NEW JERSEY N. A. S. E. BANQUET, AT KRUEGER AUDITORIUM, NEWARK, N. J.

Wing Manufacturing Co., Ludlow & Squires, Manning, Maxwell & Moore, M. T. Davidson Co., Macknet & Doremus Co., McLeod & Henry Co., Mutual Supply Co., N. Y. Belting & Packing Co., Norbin Oil & Supply Co., National Flue Cleaner Co., National Oil & Supply Co., Newark Fire Alarm Co., Otis Elevator Co., Ohio Blower Co., Peerless Rubber Manufacturing Co., Pitts & Kitts Co., POWER, Philadelphia Grease Co., R. & J. Dick Co., Ross & Taggart, Standard Regulator Co., Strong Machinery Co., Sunset Co., Schaeffer & Budenberg Manufacturing Co., Smooth-On Manufacturing Co., Strong, Carlisle & Hammond Co., Simmons Pipe Bending Works, Standard Oil Co., the Under-Feed Stoker Co. of America, V. D. Anderson Co., Walter G. Ruggles Co., Warren Webster & Co., W. B. McVicker Co., William Powell Co., Yingling & Sons.

Gas Engine Association Convention

During the semiannual convention of the National Gas Engine Association, to be held at Milwaukee on June 17 to 22 in conjunction with the gas-engine show, the following program will be presented:

On Tuesday, June 18, the gas-engine manufacturers' section (composed of members who are manufacturers of gas or gasoline engines of any kind) will discuss freight rates on gas and gasoline engines, considering their weight, the way they are packed and the small liability of breakage.

Charles Barnes, Kenosha, Wis., an attorney who has made inspection a particular study, will present this question: "Is the present system of oil inspection of any particular value, and if so, what?"

This question will also come up for discussion: "Are we satisfied with the present insurance rates issued by the Board of Underwriters? If not, will concerted action on the part of the engine builders throughout the country bring about a radical change to the benefit of our business?"

The advisability of a standard form of guarantee, to be known as the Association Standard Guarantee, will be considered during this session.

On Wednesday, June 19, the main sessions of the association will include these papers: "Lubrication and What It Means," A. E. Potter, New York; "Oil Engines," A. O. Krieger, St. Louis; "Gas Engines for the City," H. W. Jones, Chicago; "Gas Producers."

On Thursday, June 20 (Farm-Power Day): "Storage Battery in Isolated Lighting Plants," Taliaferro Milton; "Generators," C. H. Roth, Chicago; "The Tractor," L. W. Ellis, La Porte, Ind.; "How Can the Dealer Best Increase His Sales?" Open discussion, led by President Parker; "Essentials of Foreign Sales Development," Franklin Johnston, New York.

Friday, June 21 (Publicity Day): "Publicity Through the Trade Journals and What It Means to the Manufacturer," E. R. Shaw, president Federation of American Trade Press Associations; "Publicity Through the Trade Journals," W. R. C. Smith, Atlanta, Ga.; "Direct Advertising to the Dealer," C. H. Hall, Milwaukee; "General Publicity," F. E. Long, Chicago.

H. E. Miles, chairman of the committee on industrial education of the National Association of Manufacturers, will also deliver an address during the convention.

Tickets of admission to the convention and the entertainments will be secured from the exhibitors or members. When presented by the recipient he will receive a numbered badge entitling him to admission to the convention sessions (except executive meetings) and to the entertainment provided by the local committees. Every provision will be made for the comfort and entertainment of persons associated with the trade in any way or who are interested in the subject of gas-engine power, and special provision will be made that such persons be admitted to the convention during the open sessions.

Ladies' Auxiliary N. A. S. E. Convention

On May 22, the Ladies' Auxiliary of the New England Association of Stationary Engineers held its twelfth annual convention at the Benedict House, Pawtucket, R. I. Forty-five delegates, representing auxiliaries throughout New England, were in attendance. The convention had as guests National President Edward F. Kearney and Mrs. Kearney, Boston; Past National President Herbert E. Stone, Framingham, Mass.; Past National President Mrs. Nellie Moore, of the Ladies' Auxiliary, Worcester, Mass.; National Treasurer Mrs. Emma Stone, Framingham, Mass.

A revision of the bylaws was discussed and a resolution adopted petitioning the national convention for the privilege of a referendum vote of the subordinate body. It was voted to hold the thirteenth annual convention in Waterbury, Conn. The reports of the condition of the affiliating auxiliaries showed progress during the year, with one new auxiliary formed in Torrington, Conn., and one organized at New Bedford, Mass.

Officers were elected as follows: Past President, Mrs. Ollie Heckler, New Haven, Conn.; president, Mrs. E. C. Greene, Chartley, Mass.; vice-president, Mrs. Gertrude Hunt, Hyde Park, Mass.; recording secretary, Mrs. Dorothy Cole Rowe, Waltham, Mass.; treasurer, Mrs. Hannah L. Canfield, Providence, R. I.; conductor, Mrs. Nettie Pike, Worcester, Mass.; chaplain, Mrs. Nellie E. Travers, New Bedford, Mass.; doorkeeper, Mrs. Minnie T. Hallm, Springfield, Mass.

The delegates were guests of the local branch at a reception in the evening.

"Carpathia's" Crew Honored

On the arrival of the "Carpathia" in New York on May 29 from Naples, she was boarded by a committee of "Titanic" survivors bearing a loving cup and gold medal for Capt. Arthur H. Rostron and silver and bronze medals for his officers and crew.

Chairman Frederick K. Seward headed the committee and the presentation took place in the "Carpathia" dining room, where were assembled the entire ship's company.

Having feelingly thanked the committee for the loving cup and medal, Capt. Rostron said: "I will not take the credit for the achievement of that night when we went to the aid of the people of the 'Titanic.' I do not deserve this credit. My crew does, and to them I want to give my heartfelt thanks for their loyalty, valor and fidelity to the trust imposed. I cannot think of them too highly, for they have brought this honor to me and to themselves, and I feel humbly proud of what has been done for me through their valor."

Chairman Seward then spoke to the crew, saying, in part: "The eyes of the world are upon you and were upon you when you came to us on the open ocean, when we saw the 'Carpathia' coming to us out of the dawn. To all of you we wish to give our heartfelt thanks. For your hospitality, devotion, unselfishness and for all that was done for us we never can be adequately grateful, and as a slight token of that appreciation we wish you to accept the medals that we have had struck for every man and woman of this ship."

The medals bore in bas-relief a copy of the "Carpathia" going at full speed to the rescue of the "Titanic's" victims, while the reverse side bore the following:

"Presented to the Captain and crew of the R.M.S. 'Carpathia' in recognition of their gallant and heroic services, from the survivors of the S.S. 'Titanic,' April 15, 1912."

There were six gold medals, one for Capt. Rostron, Chief Engineer Johnson, Surgeon Frank E. McGee, Purser E. G. F. Brown, R. N. R.; Chief Steward E. H. Hughes and Second Engineer Marshall. Then, at the request of the committee, Capt. Rostron handed a medal to each member of the crew as they responded to their names called by Purser Brown, each man saluting the commander as he received his decoration, while his ship-

mates cheered. The junior officers received silver medals and the crew bronze.

In speaking of the honor that had been accorded to him by the United States Government, Capt. Rostron said that he was proud for himself, the officers and the crew of the "Carpathia," and for the Cunard Line, and that he believed the whole mercantile marine of the world would feel honored by it.

Cylinder Head Blown Out

The cylinder head of one of the large horizontal engines at the plant of Hahne & Co.'s department store at Newark, N. J., was blown out on Wednesday, May 29. The jam nut which held the piston became loose and dropped from the rod, causing the head to be blown out on the return stroke. The condensed steam damaged the stock adjacent to the engine room.

Boiler and Flywheel Accidents

According to the May bulletin of the Fidelity & Casualty Co., of New York City, from Mar. 8 to Apr. 13 there were 25 boiler explosions, and from Mar. 28 to Apr. 11, four flywheel explosions.

There were 47 persons killed and 81 injured by boiler explosions, and one person was killed and two injured in the flywheel accidents.

NEW PUBLICATION

MECHANICS OF HEATING AND VENTILATION. By Konrad Meier. McGraw-Hill Book Co., New York City. Cloth; 161 pages, 6x9 in.; 36 illustrations, 10 charts. Price, $5.

As its name implies this book is a treatise on the flow and resistance of fluids as applied to the practice of heating and ventilation. Especially noteworthy are the charts showing capacities and friction losses of standard iron pipes for steam and water under different conditions, and capacity and losses for sheet-iron air ducts. The arrangement of the charts is excellent for convenient, rapid and practical use. For accurate results much will depend upon the judgment of the engineer in making the proper assumptions, but a careful study of the text matter and the formulas upon which the charts are based will help in this direction.

The book treats air, water and steam as fluids governed by the same laws as applied to the design of conduits for their conveyance. This should have a decided influence in clearing up many erroneous ideas that are abroad concerning the action of steam as applied to heating at pressures below atmosphere. A thorough study of the charts and text and the solution of a few problems in pipe sizes will show the limitations in the use of steam for heating at pressures below atmosphere.

In designing systems of piping the author lays great stress on the importance of balancing the friction heads so as to equalize the flow, and the examples furnished show this done with considerable refinement. Nothing is said about arranging the piping so as to balance the distance as well. This is exceedingly important when high heads and long distances are involved as in forced circulation of hot water, while not so necessary when low heads and short distances occur as in house-heating work.

The author makes the point that individual regulation of branches by means of choke valves is unnecessary where the distributing system has been properly sized, and the work is an able demonstration of the engineering fact that even the worst layout of piping can be properly balanced in discharge by use of the tables and charts.

On page 31 the relation of the static head of the system with reference to the height of the expansion tank is mentioned. On large jobs the tank should be connected to the return and operated with air pressure of 15 lb. in addition to the static heads of the system. Better results will be obtained and the difficulty of a vacuum forming on the return of the pump will be avoided. The overhead tank at a remote point will always endanger the piping due to the fact that leaks are not easily discerned when an automatic water feeder is used. This is not so important on small plants.

The charts on gravity water circulation are excellent and very convenient for use. They undoubtedly have been verified by the author in his extensive experience in this line of work.

In the derivation formulas for chart III a slight arithmetical error creeps in. The quantity 83.8 H should be 83.7 H and for chart II the same quantity 70.8 H should be 70.4 H. These errors do not materially affect the results.

Recommendations to bring the resistance head to within 10 per cent. of the available effective head are made on page 45. Although this might be done with good results on jobs with low velocity, it is too close for high velocities, due to the charts not covering all known conditions of a piping system as finally installed. On page 73 the author suggests that reducing valves may be eliminated on long lines and the drop in pressure made available for high velocities and very small pipe sizes, in this manner balancing the radiation of the system of distributing mains with the heat generated by friction. This is entirely practical, although making the use of very low pressure impossible as required when exhaust steam is to be utilized.

Chart VII recommends 6 to 12 lb. per square foot for the drop in pressure on the entire system. This will give altogether too large a main as in most cases the total drop can be easily 100 or 144 lb. per square foot, as this would only mean ⅔ or 1 lb. pressure per square inch. The radiation from the larger main would be a more serious item of loss than the drop in pressure, to say nothing of the extra cost of larger mains and covering.

The chart and chapters on the flow of air and losses in friction in ducts are good and the values given check almost exactly with independent authorities. This chart is invaluable in arranging duct work and should have a decided influence in increasing the economy of operation over the present method of guessing and using adjustable dampers in the branches.

Mr. Meier deserves to be congratulated for his practical and useful contribution to the profession. The charts are exceedingly valuable as a guide in laying out classes of work for which the author intended them and the data given enable modifications to be made by the engineer to suit his individual conditions. They should pay a handsome return in decreased trouble in adjustment due to uncertain design.

PERSONAL

F. C. Buckley has succeeded Robert R. Keith as general manager of the Sterling Machine Co., of Norwich, Conn.

William McClellan, electrical engineer of the New York Public Service Commission, Second District, was elected a manager for a term of three years at the annual meeting of the American Institute of Electrical Engineers on May 21.

A. B. Hitzel, for several months manager of the Bernardsville, N. J., power plant for the Eastern Pennsylvania Power Co., has resigned to accept the position of general manager for the Carolina Power & Light Co. Mr. Hitzel will be succeeded by E. E. Yensel, of Scranton, Penn.

Of the 17 steel-hull steamers and 12 steel barges being built by the James Rees & Sons Co., of Pittsburg, for the Para Corporation, of South America, eight of the steamers have been erected and all will likely be finished by Aug. 1. The vessels, designed for light-draft work on the headwaters of the Para and Amazon Rivers, are of the stern-wheel type, 125 ft. long, 26-ft. beam and 3-ft. hold. They will draw 17 in. light, have a carrying capacity of 150 tons, and be driven by a pair of 9-in. cylinders with 4-ft. stroke. The boilers will be of the locomotive type, arranged for wood burning, to conform with the conditions of the country in which they are to be operated. The barges are 18x75 ft. and can be loaded to a depth of three feet.

Moments with the Ad. Editor

Another great convention of advertising men has passed into history.

Like its predecessors, it has written the story of a year's progress and bonded its future performance.

The Associated Advertising Clubs of America have formed the habit of making good their promises.

The eighth annual convention was formally opened in Dallas, Texas, on Monday, May 20, with 2,343 in attendance.

These men represented every section of the United States. San Francisco sent fifty-nine; Boston sent forty. Canada was represented by forty-eight and England had her delegates on the job.

It was international!

The gaiety and the "stunts" of the delegates but lightly veiled the real purpose of the convention—

They were there to advance the cause of Advertising as an essential factor in the world's work. They were there to create a public sentiment in favor of honest advertising, to rip from the hands of charlatans what vestiges of advertising influence they still retained.

They put Advertising one wide step nearer its ultimate goal.

Years ago no publisher ever thought of refusing an advertisement, especially if cash accompanied the order. Today no reputable magazine will take an ad from the patent medicine faker, many of them refuse cigarette and liquor advertising and one woman's magazine, at least, refuses to allow illustrations of steins and such on the ground that the paper reaches the homes of young girls before whom even the suggestion of drink must not be put.

Today the greatest offenders against decency and honor in advertising are the newspapers. They will see the light in time and the spectacle of the managing editor of one of New York's great dailies defending the clap-trap medical stuff, the fortune teller's and the patent medicine ad will seem like some dim spectre arising from the foul bed of an unhealthy morass to be blown away by a public sentiment in favor of clean, honest publicity.

Many newspapers today are exercising vigorous censorship over their advertising columns and one of them, at least, employs an advertising editor whose whole job is to run down and expose advertising fakers. Such a paper can be received into a family with full confidence in the decency of its advertising and the integrity of its editorial matter. It cannot be swayed from truth by the advertisers' pull.

Many years ago the publishers of POWER went further than has anybody else so far in declaring that only advertising which "belongs" can be put into this paper. That is to say, the product advertised must be in line with the generation or transmission of power. Only recently this concern has refused a watch ad, an automobile ad and a washing powder ad. Each was a good product made by reputable people but none "belongs" in a paper devoted to the *business side* of things.

This is a new era in advertising—a wonderful decade of tremendous advancement.

The world progresses because we are all trying to *sell* the work of our brain and hands. In the doing of it we must move outside the limited circle of our own environment. We must reach into new fields, interest new peoples, rub shoulders with other ideas, and all the time we are absorbing new knowledge.

The aim of Advertising is to do all this more quickly and more efficiently.

The printing press multiplies our messages thousands of times and those forerunners of progress, the railroad and steamship, carry them to the world. When a man advertises, he puts into black and white his commercial ambitions. The printed page staring up at him week after week makes him live up to his lithographs, else his conscience is a dead thing.

Secrecy and darkness are no longer the signs of potential success.

Clear the road, gentlemen, for more publicity in making and in selling, in publishing and in advertising.

The people want it and the people usually achieve their ends.

NEW EQUIPMENT

ATLANTIC COAST STATES

The construction of a water-works system at Dover, N. H., is under consideration. Estimated cost, $35,000.

The board of trade, Linderhurst, N. Y., contemplates the construction of an electric light system.

The construction of an electric-light plant at Newton, N. J., is under consideration. Plans are being prepared by F. O. Runyon, Newark, N. J.

Stanhope, N. J., contemplates the construction of a municipal water-works system. The estimated cost is $30,000.

The borough council has granted a franchise to the Hughestown Electric Light Co. to construct and operate an electric light plant at Hughestown, Penn.

Bids are being received by E. F. Bertolette, West End Trust Bldg., Philadelphia, Penn., for the construction of a power plant to be installed in the establishment of the H. A. Romberger Mfg. Co., at Middletown, Penn.

Plans have been completed by Wyss Thalman, Wabash Bldg., Pittsburgh, Penn., for the construction of an ice-plant for the Iron City Ice Co., on Bedford Ave., Pittsburgh.

The citizens of Sharon, Penn., have voted bonds to the amount of $85,000 for the construction of an electric-light plant.

The Virginia R.R. & Power Co. contemplates the construction of a power plant on 10th St., Richmond, Va. Estimated cost, $600,000. C. B. Buchanan, Richmond, is general manager.

SOUTHERN STATES

The Canton Electric Light & Telephone Co., has been granted a franchise to construct and operate an electric-light system at Clyde, N. C.

Plans have been prepared for the construction of water-works system and the installation of an electric-light plant at Camden, S. C. Estimated cost, $100,000. G. G. Alexander is city clerk.

Extensive improvements to its power plant are contemplated by the Florence Electric & Utility Co., Florence, S. C. W. L. Clark is manager and purchasing agent.

Bids will be received about July 1 for the construction of a water-works system at St. George, S. C. J. N. Johnson, Florence, S. C., is consulting engineer.

Brookville, Miss., contemplates the construction of a water-works system at a cost of $85,000. T. S. Gay is town clerk.

The proposition to issue bonds for $170,000 for the improvement and extension of the water-works system at Meridian, Miss., is under consideration.

The construction of an electric-light plant at St. Elmo (Hester post-office), La., is contemplated by the Bayou Cane Land Co. I. P. Brady, Machea Bldg., New Orleans, La., is president.

CENTRAL STATES

The Cleveland Ry. Co. has been authorized to expend $139,000 for the equipment of a new substation at Cleveland, Ohio. J. A. Stanley is president.

The Anglaize Power Co., Defiance, Ohio, contemplates the construction of a power plant at Cloverdale, Ohio.

The construction of a water-works plant at Edgerton, Ohio, is under consideration. Estimated cost, $30,000.

The director of public works has been authorized to receive bids for the construction of a filtration plant at Sandusky, Ohio.

Bids will be received until June 11 for the construction of a pumping plant and electrical equipment to be erected in connection with the water system at Bedford, Ind.

Plans are being prepared by J. F. Cole, South Bend, Ind., for the construction of a water-works system at West Terre Haute, Ind. R. Paige is town clerk.

A franchise has been granted to E. B. Hillman, Wyoming, Ill., to construct and operate an electric-light plant at Bradford, Ill.

The village board of Buckley, Ill., is considering the construction of an electric-light plant.

Bids will be received until June 14 for furnishing a 90-hp. variable speed motor direct connected to a 3,000,000-gal. 16-in. centrifugal pump for the water-works at Rockford, Ill.

The Oakfield Light & Power Co., Oakfield, Wis., is receiving bids for the construction of an electric-light plant. W. E. Bristol is interested.

A franchise has been granted to Dahl & Shipley to construct and operate an electric-light plant at Big Falls, Minn.

Bids will be received by the village clerk, Jackson, Minn., until June 11, for furnishing electrical equipment for the electric-light plant. E. D. Jackson, St. Paul, Minn., is consulting engineer.

Bids will be received by R. J. Hill, village clerk, Lakefield, Minn., until June 11, for electrical equipment.

WEST OF THE MISSISSIPPI

The Boone Electric Light Co. has been granted a franchise to construct and operate an electric-light system in Ames, Iowa. John Reynolds, Boone, Iowa, is general manager.

The citizens of Dow City, Iowa, are considering the construction of an electric-light and power plant.

W. A. Milroy contemplates the construction of an electric-light system at Hopkinton, Iowa.

The construction of an electric-light plant in connection with the water-works system at Shellsburg, Iowa, is contemplated by the council; also the installation of an electric-light system.

The town board has been authorized to receive bids for the construction of a municipal water-works system at Ethan, S. D. Estimated cost, $7500.

The Sioux Falls Light & Power Co. contemplates the construction of a steam power plant at Sioux Falls, S. D. Estimated cost, $200,000. A. H. R. Jackson is superintendent.

The citizens of Underwood, N. D., have voted a bond issue of $8000 for the construction of an electric-light plant.

Plans are being prepared by Worley & Black, Reliance Bldg., Kansas City, Kan., for the construction of a new water-works system at Chanute, Kan.

The citizens of Coffeyville, Kan., have voted bonds to the amount of $130,000 for the construction of a municipal water-works system.

Contract will be awarded about July 1 for the construction of a power plant at Cedar Bluffs, Neb. Estimated cost, $7000. J. H. Maskprang is village clerk.

The construction of a water-works system at Eustis, Neb., is under consideration. Estimated cost, $16,000. J. P. Pickering is chairman of the village board.

The construction of an electric-light plant at Cowley, Wyo., is contemplated by A. W. Ditto, of Gillette.

The San Antonio Traction Co. contemplates the installation of a 3000-kw. generator and other electrical machinery in its substation at San Antonio, Tex. Howard Henson is purchasing agent.

The Texas Power & Light Co. has been incorporated to construct a power plant at Waco, Tex. Estimated cost, $100,000. J. F. Strickland, Dallas, is president.

The Oklahoma Power & Light Co., Oklahoma City, Okla., is considering the construction of an electric power plant to cost about $1,500,000. Croslen & Chappelle are engineers.

The Sand Springs Light, Heat & Power Co. contemplates the construction of an electric-light system in Tulsa, Okla. Charles Page is interested.

Bids will be received about July 1 for the construction of a water-works system at De Beque, Colo. Estimated cost, $20,000. Lambert Stimberg is mayor.

Plans are being prepared by P. D. Sheppard, Denver, Colo., for the construction of a water-works system at Fountain, Colo.

An expenditure of $20,000 is planned for the improvement of the water-works system at Greeley, Colo.

John Keyes of Oklahoma City, Okla., has purchased the plant of the Artesia Electric Light & Power Co., Artesia, N. M. Considerable improvements to the plant are planned by the new owner.

The citizens of Weiser, Idaho, are considering the proposition to issue bonds for $85,000 for the installation of a municipal water-works system. R. J. Wood is secretary of the commercial club.

The Douglas Light & Power Co. contemplates the construction of an electric-light plant at Florence, Ariz. F. E. Arthur is interested.

The construction of an electric-light plant at Ephrata, Wash., is contemplated by Martin Kramer.

The citizens of Palo Alto, Calif, have voted bonds to the amount of $35,500 for the construction and equipment of an electric-light plant.

San Rafael, Calif., contemplates the construction of a municipal water-works system. C. J. B. Cheda is interested.

The St. Thomas Light, Heat & Power Co. is considering plans forthe construction of an extension to its substation at St. Thomas, Ont. E. H. Caughell is acting manager.

The date for receiving bids by S. E. Whiting, president of the Bassano Electric Power & Traction Co., Bassano, Alta., for equipment for an electrical generating station, has been extended from June 3 to June 17.

The power plant at Moose Jaw, Sask., was destroyed by fire, May 25, causing a loss of $500,000.

BUSINESS ITEMS

E. L. Murray has succeeded F A. Buss as Chicago representative of the Ohio Brass Company, Mansfield, Ohio.

The Federal Metallic Packing Company has moved its offices from 164 Canal street to 48 Hanover street, Boston. Mass,

"The Bruce-Macbeth Engine Company, Cleveland O., recently sold three engines within one week, all three to Glass Companies, all three of which had previously had one or more of Bruce-Macbeth Engines, and all three run on 24 hour service."

The Lagonda Manufacturing Company, Springfield, Ohio, which manufactures the Weinland Boiler Tube Cleaner, Lagonda Cut-off valve, Water Strainers, etc., has erected a three-story modern office building which, in connection with the addition recently made to the factory, will mean an end to delays due to the rapid increase of business.

NEW CATALOGS

"S-C" Regulator Co., Fostoria, Ohio. Catalog. Water level regulators, pump governors Illustrated, 24 pages, 6¼x9½ in.

The E. Keeler Company has issued its 1912 catalog and it is well worth securing. It gives the complete details of the Keeler Water Tube Boilers and many construction illustrations are shown. The catalog also illustrates many typical Keeler installations and contains much information of value to boiler buyer and boiler user. Copy will be mailed on request.

One of the most artistic and complete catalogs of Mechanical Rubber Goods that we have ever seen is the 160 page catalog recently issued by The Diamond Rubber Co., Akron, Ohio. Each page shows an illustration of the article described at the top and the product in actual service shown at the bottom. The catalog is divided into sections on Transmission Belt, Conveyor Belt, Hose, Packing, Moulded Goods, Mats and Matting, Hard Rubber. Valuable information covering data on Belting, Hose, Packing, etc., are scattered plentifully throughout the entire book. The design of the cover illustrates the wide range of industries that use Diamond Products. The book is sent free. Write to the company if you want a copy.

ENGINEERS WANTED

Under this head are published, without charge, advertisements of actual vacancies in power plants for operating engineers and assistant engineers. For the guidance of applicants for advertised positions, the advertisements must contain particulars to show the class of service demanded and the wages paid. Employers who desire to advertise under this head are requested to write for a blank form of application.

FIREMAN—First class man, sober, steady, industrious, in light and power plant, seaside resort in N. J. two Heine boilers 308 hp. each, shaker grates, burn soft coal, one pump. All night work, 12 hours, during summer; same hours, two weeks day and two weeks night during winter, when tubular boilers are operated. Salary $75 per month; steady job. Write, stating experience and references. Box 678, Power.

HELP WANTED

Advertisements under this head are inserted for 25 cents per line. About seven words make a line.

SALES AGENTS to sell Goetze Metallic Packings of good reputation. Write us. Goetze Gasket & Packing Co., New Brunswick, N. J.

SALES MANAGER. A prominent manufacturer of power specialties desires to secure the services of an experienced Sales Manager, capable of taking entire charge of the Sales Department. Must have a good general Engineering knowledge of power plant design and operation, acquainted with the jobbing trade and how to handle it, as well as having had experience in writing advertisements. Applicants will state age, education, experience in detail and salary expected. Address 676 Power.

SALESMAN—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," Power.

STOKER ERECTORS, first class; none but experienced men need apply; state age, salary wanted, habits and references. Box 668, Power.

THE VULCAN SOOT CLEANER offers an exceptional opportunity for power specialty salesman. Address G. L. Simonds & Co., 802 Steinway Bldg., Chicago, Ill.

AGENTS WANTED to sell forced draft blowers and damper regulators; will give exclusive territory to right parties; commission on sales. Turbo-Blower Co., 30 Church St., New York.

AGENTS selling to steam plants can make big money selling for us; no samples; no experience is necessary. Armstrong Mfg. Co., Springfield, Ohio.

MANUFACTURERS' AGENTS to handle thoroughly guaranteed steam specialties; feed water heaters, steam and oil separators, traps and exhaust pipe heads; not necessary to represent entire line if interested in only part of it; our specialties are well advertised and of good reputation. Box 569, Power.

SALESMEN—We need more local sales representatives; we manufacture a specialty for waterworks and industrial plants; a valuable agency for energetic men; commission only; now open, Vancouver, Edmonton, Montreal, Pennsylvania, most of the southeastern states and far southwestern states; we prefer steam specialty salesmen now handling other lines or engineers with sales ability. Box 669, Power.

SITUATIONS WANTED

Advertisements under this head are inserted for 25 cents per line. About seven words make a line.

CHIEF ENGINEER, 15 years' experience, runs large railway and lighting station, also isolated plants, experience both reciprocating engines and turbines, knows combustion and fuel economy, wants plant within 20 to 30 miles New York City. Box 677, Power.

MISCELLANEOUS

Advertisements under this head are inserted for 25 cents per line. About seven words make a line.

PATENTS SECURED—C. L. Parker, Patents, 904 G St., Washington, D. C.

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write today. M. Y. C., 1417 W. Jackson Blvd., Chicago, Ill.

FOR SALE

Advertisements under this head are inserted for 25 cents per line. About seven words make a line.

FRANKLIN WATER TUBE BOILER, 182 hp., used three weeks. Franklin Boiler Works Co., Troy, N. Y.

ONE 120-kw. a.-c., 440-volt Westinghouse generator. One 16x42 Allis Corliss engine, complete with all fittings, including exciter and switchboard. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

350 KW. WESTINGHOUSE direct current generator, 250 volts, direct connected to 24x36 heavy duty Corliss engine; unit complete with switchboard, balancing set, etc. Arthur S. Partridge, 417 Pine St., St. Louis.

75-KILOWATT gas producer plant; after two years of service, discontinued on account of increased power requirements; complete with all auxiliaries; price very low; quick sale is desired. For particulars address Box 670, Power.

CORLISS ENGINES: 5000 hp. Allis vertical cross compound Corliss; 1200 hp. Hamilton horizontal cross compound Corliss; 750 hp. Filer & Stowell cross compound horizontal heavy duty with condenser. Arthur S. Partridge, 417 Pine St., St. Louis.

500 HORSEPOWER right-hand engine; simple Corliss heavy duty frame, size, 24x48, complete, including flywheel, 18 ft. diameter, grooved for 14 turns 1¼-in. rope. American drive-steam receiver separator, 7-in. steam pipe including one long radius bend and flanges; can be seen in operation at our mill in Mt. Carmel, Ill. Address Bernet Craft & Kauffman Mfg. Co., Office 1036 Pierce Building, St. Louis, Mo.

ONE HEWES & PHILLIPS Corliss engine, 14x36 in., in excellent condition; flywheel, 10 feet diameter, 18 in. face, five to six years old. One 75-kw. a.c. Westinghouse generator, 3 phase, 220 volts, 60 cycles, 900 r.p.m. with switchboard and exciter complete. One 50-kw. a.c. Westinghouse generator, 3 phase, 220 volts, 60 cycles, 1200 r.p.m. with switchboard and exciter complete. One 45-kw. d.c. General Electric generator, 115 volts, 850 r.p.m., with switchboard complete. The Salt's Textile Mfg. Co., Bridgeport, Conn.

100 HP. SCOTCH MARINE BOILER, 18 months old, 125 lbs. Hartford insurance, butt-strapped, triple riveted, $500 f.o.b. Sunbury, Ohio. Room 673, 50 Church St., N. Y.

Two (2) 72 in. x 14 ft. return Tubular Boilers (103 3½" Tubes each) working pressure 110 lbs. and 90 lbs. respectively complete with plate steel fronts and cast iron trimmings, one (1) Westinghouse Compound Engine (Cylinders 8x13x8), direct connected with a d.c., 25-kw., 125 volts General Electric Generator including one (1) 200 Ampere Meter, Circuit Breaker and Rheostat. Reason for selling, larger installation. For price and information, write McCormick & Co., 105 Concord St., Baltimore, Md.

ONE 500-horsepower Hoppes live steam purifier; one 35 kilowatt General Electric, 230 volt steam turbine and dynamo and switchboard panel; one complete Emerson steam pump, including working barrel, capacity 200 gallons per minute; two Worthington water meters; one iron tank, 60,000 tensile strength, 42" diam. and 9' high; two Bundy traps No. 100 and No. 52 series; two Anderson traps No. 3 and No. 2. All in A-1 condition; will sell cheap. Box 656, Power.

20x40x48", 30x60", 16x32x48", 24x42", 20x42", 18x36", 14x36", 12x24" Corliss engines, 12x20x14 Ideal, 10x11" Chuse, 9x14" straight line, 9x12" Russell, 60x20, 66x20, 72x22 butt strap boilers; heaters, pumps, compressors, etc. John Ramming Machine Co., Main St. and Clark Ave., St. Louis, Mo.

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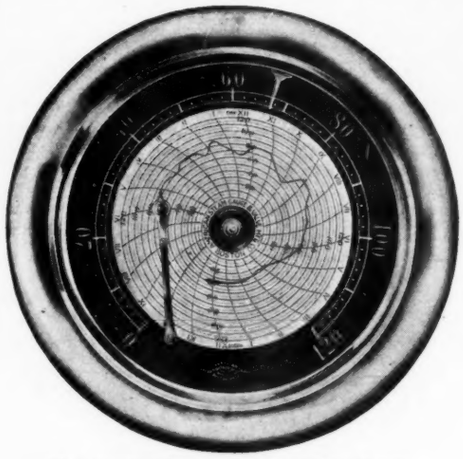
Prove That You Are "Saving Money" For Your Employer



The American Pressure and Recording Gauge.

American Steam Gauges Will Help You

You may know that you are saving money for the concern that employs you, but how are you going to prove it? It's one thing to know that you are really ***worth*** advancement, but it's a horse of another color to convince your employer that this is so.

Facts and figures will do it.

Instead of having to rely on bare statements to show that you are worthy of advancement, you have visible proof in the shape of indelible records made by the **American Combined Pressure and Recording Gauge.**

This instrument shows at any time of the day or night, it shows at every hour that coal is being burned, just what is being done in the boiler room.

It shows in the plainest kind of way whether or not the fire is being watched carefully, shows whether the pressuse is being kept up as it should, shows whether or not you are on to your job.

And the records, being kept, furnish an exact record of what has been done day after day, week after week, for years.

They compel the man in charge to see that your work is being attended to in a way that means "money saved" to the house.

They ***force*** recognition of work well done.

American steam gauges are built to record pressures exactly—not approximately—and to record them exactly always—not generally.

Write For Pocket Edition Catalog

You'll surely appreciate this book. It not only describes the device herewith illustrated, but also goes into the full story of the complete line of American Quality Power Plant Products. This Pocket Edition will cost you nothing. It is a book worth having and we want to send you a copy. Write today—the coupon brings it.

SIGN AND MAIL COUPON

American Steam Gauge & Valve Mfg Co.
Boston, Mass. 6-11-12

Send me your Pocket Edition Catalog.

Name. . . . . .

Address. . . . . .

American Steam Gauge & Valve Mfg. Co.

Boston, Mass.

Sales Offices in New York, Chicago, San Francisco, Pittsburg, Atlanta, Montreal

THE BEST HOUSES EVERYWHERE SELL OUR PRODUCTS

He Needs "VEELOS"

The Power Plant Engineer, whose judgment 9 times in 10 can make or break a sale for any part of his equipment, needs "Veelos" Balta Belting; because it will give him less trouble and will wear longer than any other belt he can use.

The Engineer who uses "Veelos" is the man who knows.

The Strongest Belt Made

Manufactured from the highest grade cotton duck and thoroughly impregnated with the best Balta Gum, "Veelos" belting contains every qualification that can go into the making of a belt of great strength.

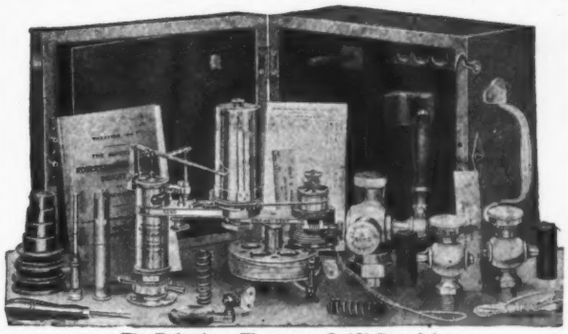
"Veelos" belting will not slip, it will not wear on the edges, it has the least stretch of any belt known, it runs true, is uniform in quality, and absolutely oil, steam, and water proof.

Write us, Mr. Engineer, and get a large size sample and test for yourself, our claims. Every inch of "Veelos" belting is guaranteed.

Live agents wanted in unoccupied territory.

Manheim Manf. & Belting Company

Manheim, Lancaster Co. Pennsylvania



The Robertson-Thompson Outfit Complete

Pick Out The Engineer

you would like to be like and you will find he owns a good indicator and has made himself prominent by its use and the knowledge he has gained. Of the many thousands of

ROBERTSON THOMPSON OUTFITS

in use, more than likely his progress is due to the superior merits of these instruments.

Why not you be as "classy" as he? The indicator opens the only sure way to be independent in your profession, and there never was such an opportunity to get a surely high grade, guaranteed instrument at such a low price as NOW.

Let us give you further particulars

Jas. L. Robertson & Sons

76-78 Murray Street, New York City

Is There Any Logic

in buying a "just as good" article when the genuine goods can be had at about the same price and in many cases lower.

Eureka Flat Gum Core Packing

has had a national advertisement by those who trade on the reputation of a good name, offering something just as good. Don't be deceived—no substitute or imitation is as good as the genuine. One has a reputation to uphold—the other don't care a _____? after being paid—Be fair to the goods that have given you satisfaction. Refuse those "just as good." Your dealer carries genuine Eureka.

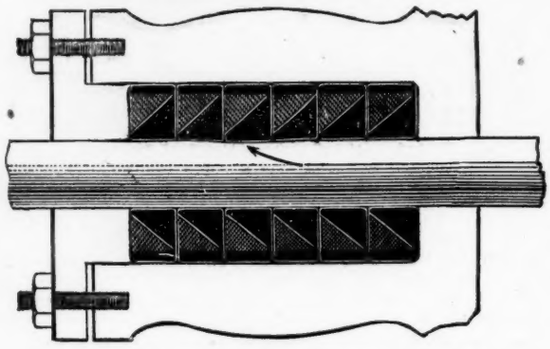
Eureka Packing Co.

76-78 Murray St. New York City

COMBINATION

(Trade Mark Registered)

Steam and Hydraulic Packing



Get Its Construction

It has the advantages of any of the old style sectional packings—and many of its own. Soft Flax only forms the wearing surface, while the back of Pure Rubber gives it elasticity. The expansion of rubber alone will keep it tight.

Ask your dealer for a sample or send to

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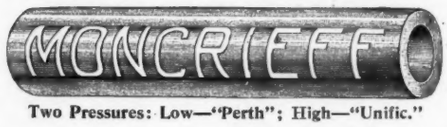
64 India Street, **BOSTON, MASS.**

Or Advance Packing and Supply Co., 123 Franklin St., Chicago.

Never Excelled



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